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MASSACHUSETTS
AGRICULTURAL EXPERIMENT STATION

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Annual Report

For the Fiscal Year Ending Nov. 30, 1929

The main purpose of this report is to provide an opportunity for presenting in published form, recent results from experimentation in fields or on projects where progress has not been such as to justify the general and definite conclusions necessary to meet the requirements of bulletin or journal.

MASSACHUSETTS
AGRICULTURAL EXPERIMENT STATION

Requests for Bulletins should be addressed to the

AGRICULTURAL EXPERIMENT STATION,
AMHERST, MASS.

MASSACHUSETTS AGRICULTURAL EXPERIMENT STATION

JUL 23 1930

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CONTENTS

Introduction	328
Department of Agricultural Economics:	
Consumer demand for apples	329
The economic worth of different varieties of apples	329
The nature of the consumer demand for poultry products	329
Part-time farming	329
Prices of eggs and poultry products	329
The study of competitive factors influencing the supply of market milk and cream in Massachusetts	330
Department of Agricultural Engineering:	
Investigation of apple storages	330
Fertilizer distributors	331
Department of Agronomy:	
Nitrogen assimilation by Havana tobacco	331
Relation of the form of nitrogen to root-rot of Havana tobacco	331
Nitrogen assimilation by grasses and clovers	332
Ecological study of pasture vegetation	332
Alfalfa variety tests	332
Tests of varieties of soy beans and field peas	332
The value of cover crops for onions	333
Sulfate versus muriate of potash for onions	333
Lime in relation to onion growth	333
Fertilizer ratios for onions	334
Onion breeding	335
Influence on onions of rate of seeding and spacing between rows	335
Relation of aluminum compounds to the ill effects of certain crops when grown in rotation	335
Quantity of nitrogen and phosphorus for tobacco	337
The magnesium requirement of certain common crop plants	338
Department of Bacteriology and Physiology:	
Nitrogen-fixation in relation to legumes and non-legumes under defined agronomic conditions	338
Laboratory service	339
Studies on the indol tolerance of the Colon-Aerogenes group of bacteria as a possible means of differentiating fecal and non- fecal strains occurring in drinking water supplies	340
Department of Botany:	
Tobacco diseases	340
Black root-rot	340
Brown root-rot	341
Control of diseases of greenhouse vegetables	341
Leaf-mold of tomatoes	341
Downy mildews of cucumber and lettuce	342
Eradication of nematodes in greenhouse soils	342
Eggplant wilt	343
Onion blast	343
Carnation blight	343
Forcing gladiolus with the aid of artificial light	343
Influence of light quality on plant growth	344
The effect of pot structure on soil temperature	344
The Cranberry Station:	
Injurious and beneficial insects affecting the cranberry	345
Cranberry disease work	345
Weather observations with reference to frost prediction	346
Varieties	346

Department of Dairy Industry:	
A study of packaged ice cream	346
The quinhydrone electrode in the dairy laboratory	347
The utilization of frozen fruits in ice cream	347
A study of frozen sweet cream for use in ice cream	347
A study of electric refrigerated milk cooling tanks	348
A study of the changes that occur in the storage of frozen sweet cream	348
Department of Entomology:	
Dates of hatching of scale insects and when to spray for them	348
Investigation of materials which promise value in insect control	348
Control of onion thrips	349
Spray residue problem and its relation to orchard practices	350
Control of the plum curculio in apples	350
Biology and control of the carrot rust fly	350
Systematic study of oil sprays	351
Farm Department:	
Intensive grassland management under the Hohenheim system	351
Department of Farm Management:	
Enterprise relationships and farm organizations on selected dairy farms in western Massachusetts	352
The place of poultry production on Massachusetts farms	353
Types of farming in Massachusetts 1840-1925	353
Factors responsible for variations in production and cost of milk in Massachusetts	353
Other activities	353
Feed Control Service:	
Feed control	353
Seed control	353
Dairy law	354
Advanced registry testing	354
Miscellaneous work	354
Fertilizer Control Service:	
Fertilizer inspection	355
Miscellaneous analytical work	356
Vegetation pot experiments	356
Department of Home Economics Research:	
Present practices of Massachusetts elementary schools with regard to school feeding and transportation and their effects upon health of pupils	357
The comparative value of milk and tomato as supplementary feeding in a rural elementary school	357
Department of Horticultural Manufactures:	
The extraction of fruit juices by heat	358
Manufacture and preservation of cranberry products	358
Utilization of onions by canning	358
The nitrogen distribution of the edible portion of the onion	358
Utilization of frozen fruits in ice cream	358
Pasteurization of dried fruit	359
Non-project research	359
Department of Landscape Gardening:	
Lawns and lawn grasses and lawn management	359
Department of Plant and Animal Chemistry:	
The efficiency of copper fungicides	360
Supplements for copper fungicides	360
The effect of fertilizer and cultural treatment on the nitrogenous compounds of Havana seed leaf	360
Oil sprays	360
Nitrogen fixation in the presence of or as a result of the growth of legumes versus non-legumes under certain defined agronomic conditions	360

Chemical changes in the cranberry during ripening and after harvesting	361
Record of the Station herd	361
Milk substitutes in the growing of young calves	362
Mineral supplements for dairy cattle	362
Mineral constituents of forage crops	362
Mineral requirements for the growth of dairy heifers	362
A comparison of two systems of dairy cattle feeding—high roughage and low grain versus low roughage and high grain	362
The chemical composition of grass from plots fertilized and grazed intensively	363
Utilization of onions by canning	363
Department of Pomology:	
The interrelation of stock and scion in apples	365
Tree characters of fruit varieties	365
The genetic composition of peaches	366
Testing methods of pruning	366
Effect of pruning on bearing apple trees	366
Comparison of cultivation and sod in a bearing orchard	366
Comparison of clover sod and grass in sod mulch orchard	366
Tests of different amounts of nitrate of soda	367
Comparison of cultivation and heavy mulching for apples and pears	367
The effects of fertilizer limitation on fruit plants	367
Role of potash and lime in fruit tree nutrition	367
Effect of potash and lime on apple trees	367
Study of varieties of tree fruits	368
Fruit bud formation in the strawberry	368
Work not on a project basis	
The "set" of McIntosh apples in Middlesex and Worcester counties	368
A study of the storage of McIntosh apples under various conditions	369
Cross-pollination and sterility studies with certain apple varieties	369
Studies of the arsenical residue on apples	369
Department of Poultry Husbandry:	
Broodiness in poultry	370
Breeding poultry for egg production	370
Statistical study of heredity in Rhode Island Reds	370
A genetic study of Rhode Island Red color	370
Determination of genetic laws governing results in inbreeding poultry	370
Heredity and environmental characteristics affecting variability in egg production	371
Factors governing egg weight and shell character in domestic fowl	371
Relation of intensity or rate of laying to feather pigmentation	371
Department of Vegetable Gardening:	
Conditions affecting the production and vegetative propagation of Washington asparagus	371
Cold resistance in sweet corn in its relation to quality, size, and earliness	375
Greenhouse lettuce	375
Improvement of vegetable varieties through root and seed selection	375
The genetics of greenhouse cucumbers	375
Department of Veterinary Science:	
The cutaneous vaccine for fowl pox	376
Laboratory service	376
Poultry disease elimination law	376
Farm and Station Bang's disease	377
Publications	377
Changes in staff	382

ANNUAL REPORT OF THE MASSACHUSETTS AGRICULTURAL EXPERIMENT STATION—1929

INTRODUCTION

F. J. Sievers, Director

With the rapid industrial changes and developments which have been especially evident during the last half century throughout many portions of the world, and particularly in this country, an increasing portion of the consuming public has become farther removed from its direct dependency upon products of the farm. Prior to this period of marked industrial progress, or evolution, the difficulty of wresting the products of agriculture from the soil and of preparing them for use was so pronounced that it required practically all of the labor of our entire employed population. The farm and the home furnished the main market for the employment of labor; and the demands of the average consumer, beyond the bare necessities of life, were comparatively few. This applied especially to those demands that involved cash expenditures. The expenses and cash outlays for most farm practices were not considered sufficiently significant to make it necessary to keep farm accounts or to determine with any degree of accuracy just what the costs of farm management operations were. That the economics of farm and home management did not require the same consideration as today is evidenced by the fact that many farms and farm homes were maintained for long periods of time even though there was little indication of cash income.

Coincident with the economic conditions during this period, investigational work at the experiment stations was largely concerned with projects pertaining to quantity production, and little consideration was given to the matter of costs and quality. As a result many practices that were developed and considered scientifically sound, based on such an economic or lack of economic background, are found to be no longer satisfactory under present systems where costs of operation and consumer's demand for quality in product are factors of foremost consideration.

An up-to-date program of research in agriculture as it pertains to present-day practices on the farm and in the home must not only give the same consideration as formerly to quantity of product, but is further complicated by the demand that results must be interpreted on a basis where the economics of production and the quality characteristics of the product are properly evaluated. In the promotion of research at Massachusetts Agricultural Experiment Station it has been the hope to maintain this desirable balance, and the progress made during the last year on the several projects under investigation is reported in the following pages.

DEPARTMENT OF AGRICULTURAL ECONOMICS

Alexander E. Cance in Charge

Consumer Demand for Apples. (Lorian P. Jefferson). The study of the consumer demand for apples has been divided into three parts. The first two sections, "The McIntosh Apple on the New York Market" and "A Study of the Consumer Demand for Apples", have already been published as Bulletins 243 and 250 respectively. The third section deals with the competition between apples and other fruits, and between different varieties of apples. The data for making these comparisons have been secured from public and private records, and much of the statistical work has already been done. The study will be completed in 1930.

The Economic Worth of Different Varieties of Apples. (Lorian P. Jefferson). This project, which has been under way for several years, has still two years to run. Data are being secured for a series of seasons, numbers of trees, yields by grades, and prices, looking to a determination as to which varieties are the most profitable for Massachusetts growers. While the statistics already secured have been tabulated, no summary has yet been made nor has any attempt been made to draw conclusions.

The Nature of Consumer Demand for Poultry Products. (Lorian P. Jefferson). This study is based on data collected from consumers and retailers, and should supply information as to the type of demand in specific markets through the State and thus be of use to both producer and dealer. The gathering of this material has not yet been completed.

Part-Time Farming. (David Rozman). The field work in connection with the project on part-time farming is now completed, and the material is being prepared for publication. Three different areas were investigated.

A house to house survey was carried on in the town of Holden with a view to determining the extent and relative importance of part-time farming in a rural community. As a result it was found that of 585 operators engaged in some kind of agricultural activities in the town of Holden, 519 were part-time farmers, and only 66 bona fide farmers. Part-time farmers contributed 42.6 per cent or almost one-half of the total value of agricultural products raised in Holden.

A second part of the study was carried on in the Lowell and Taunton areas represented by towns situated in the vicinity of these industrial centers. The main object of this part of the investigation was to determine the economic and social set-up of a representative group of part-time farmers. To this end a number of part-time farmers in both areas were visited with a detailed questionnaire taking records of their occupations, date of settling on the land, extent of farming operations, living conditions, and earnings both on the farm and outside of it. A total of 115 records was obtained in the Lowell area and 84 in the Taunton area.

The data obtained in this study portray an important feature of Massachusetts agriculture and have a special bearing on the problems of land utilization, food supply, and agricultural competition in the State.

Prices of Eggs and Poultry Products. (A. H. Lindsey). Until September 1 this project was under the leadership of H. W. Yount, who completed the work on the first two parts. Data have been gathered and tabulations and correlations completed for part three. Eggs were purchased in the

Boston market in April and August to supplement November data, as quality factors do not have the same relation to price at different seasons of the year. Price factors as determined in the study have been used in forecasting the price of eggs throughout the year.

Wholesale price quotations on the Boston market form the basic material for the study. The trend of egg prices since 1904 has been upward to 1916 and sharply upward to 1920. Since 1920 the trend has been downward, declining more abruptly after 1925. Although consumer's purchasing power has been increasing since 1920, the increasing receipts have been such as to cause a decrease in the corrected prices to a point below the price in the period ending 1916.

The seasonal movement shows a definite change since 1920. The period of high prices in the fall occurs earlier, and the decline from the high period to the low point of prices is more rapid than formerly.

Prices are determined by the operation of a number of factors. The importance of the various factors changes during different periods of the year. From April to November, during the period of rising prices, demand factors have a greater influence in price determination than supply factors. In the same way, during the period of falling prices from the third week in November to early in April, the supply factors are dominant.

The Study of Competitive Factors Influencing the Supply of Market Milk and Cream in Massachusetts. (A. E. Cance). Very little has been done on this project during the year owing to lack of time. During the year 1930 it is hoped to make a study of the demand for special milk in certain cities and towns in Massachusetts and to make a survey of the changes in the local supply areas, with a view to a better understanding of the effect of prices and demand on local milk production in Massachusetts.

DEPARTMENT OF AGRICULTURAL ENGINEERING

C. I. Gunness in Charge

Investigation of Apple Storages. (C. I. Gunness). The purpose of this investigation is to determine what is a satisfactory and economical storage house for McIntosh apples. A study of weather data and soil temperatures indicates that a common storage without artificial cooling can not be depended upon to provide sufficiently low temperatures to give proper storage for an early variety of apple like the McIntosh. The use of ice in cooling an insulated storage has been found to reduce the temperature about 10° when fans are used to circulate air over the ice. It is quite evident, however, that under present labor conditions it is not practical to use ice for artificial cooling in competition with mechanical refrigeration. During the present season an investigation is being carried on in cooperation with the Department of Pomology on the maximum temperature at which apples can be stored satisfactorily. Three lots of apples were stored at 45°, 40°, and 32° from picking time until December 1. The apples were then all placed in the 32° room for the balance of the season. No results are available as yet. Another phase of the investigation deals with the efficiency of different floor materials as insulators.

Fertilizer Distributors. (C. I. Gunness). A study of two types of broadcast distributors indicates a great difference in the uniformity of application by the various machines. No results can be given at this time as additional machines are to be tested, and all are to be tested with a variety of materials.

DEPARTMENT OF AGRONOMY

A. B. Beaumont in Charge

Nitrogen Assimilation by Havana Tobacco. (A. B. Beaumont). Two nitrate salts, four ammonium salts, ammonium nitrate, and fifteen organic nitrogen compounds were used. In the selection of organic carriers preference was given those amino acids reported as constituents of cottonseed, since cottonseed meal is the principal carrier of nitrogen in Connecticut Valley tobacco fertilizers. Cottonseed meal, itself, was used. Several series of plants were grown in non-sterile and sterile water and sand cultures. Analytical data on the chemical composition of the web of the leaf were obtained for plants grown in non-sterile water cultures. (Analyses were made by P. R. Nelson of the Chemistry Department.)

Taking yield data, growth characteristics, and chemical composition as criteria of assimilation, it is concluded that, of the various nitrogen compounds studied, the nitrates are the most readily assimilated by Havana tobacco, with urea, ammonium salts, asparagine and cystine next in order of assimilation. Of the various amino acids of cottonseed meal, only one, cystine, showed any appreciable assimilability; and cystine is said to be present in cottonseed in small amounts only. Cottonseed meal itself, or its hydrolyzed products, gave no evidence of being assimilated in the unchanged form. Evidence points toward the need of ammonification and nitrification of this organic nitrogen carrier before it can be fully assimilated by Havana tobacco.

Relation of the Form of Nitrogen to Root-rot of Havana Tobacco. (A. B. Beaumont). Ammonium salts and certain amino and amide compounds have been found toxic to Havana tobacco in varying degrees. Browning and rotting of the roots and dying and dropping of the lower leaves were symptoms that accompanied this toxicity when the plants were grown in unsterilized media and containers. Tobacco grown under sterile conditions, but with the same forms of nitrogen, produced clean white roots. This is taken as evidence that the symptoms mentioned are secondary rather than primary effects of the form of nitrogen used.

Plants grown in unsterilized solutions containing nitrogen as sodium or calcium nitrate or urea produced healthy roots of a white or slightly brownish white appearance. Mixtures of nitrates and ammonium salts were toxic in proportion to the concentration of the latter. Nitrate nitrogen tended to counteract the ill effect of ammonium nitrogen on tobacco. In view of the data obtained, the toxicity of ammonium salts and certain organic compounds cannot be satisfactorily explained on the ground of either physiological acidity or hydrogen-ion concentration. Rather, it seems that improper metabolism caused by poor assimilation of nitrogen offers the best explanation of all but the extreme cases of toxicity.

Nitrogen Assimilation by Grasses and Clovers. (A. B. Beaumont).

Data secured thus far indicate that nitrogen in the form of nitrate, ammonium salts, and urea is assimilated by the common tame grasses. No distinct differences in growth in the respective media have been obtained, as was the case with tobacco. Some, but inadequate, evidence has been obtained that clovers assimilate nitrogen directly from nitrates and urea but not from ammonium salts.

Ecological Study of Pasture Vegetation. (A. B. Beaumont). Further data have been obtained on the effect of lime and fertilizer nutrients on the growth of pasture vegetation. Yield records have been secured from certain plots; but on account of the excessive summer drought, differences which have appeared in other seasons did not show in the figures. In a new experiment with different forms of nitrogen applied as top dressings, the quick response of pasture grasses to nitrates, ammonium salts, and urea was very evident. Response to calcium cyanamid was slow. Subnormal rainfall may have been a significant factor in the behavior of the cyanamid. From our several experiments with nitrogen compounds it is very clear that comparatively large amounts of nitrogen do not eliminate white clover from the pasture flora.

Alfalfa Variety Tests. (A. B. Beaumont and R. E. Stitt). Further evidence has been obtained which shows that certain varieties of alfalfa originating in southern climates are not winter-hardy in Massachusetts. Tentative ranking of ten varieties grown in Test No. 1, in decreasing order of hardiness after two winters, is as follows:

1. Hungarian
2. Grimm, Ontario Variegated, Utah, Kansas, Dakota 12
3. Cossack, Argentine
4. Arizona, Ladak

No outstanding differences have appeared which could be attributed to fertilizer and lime treatments. At this stage of the test, it is very evident that varietal or strain differences are much more significant than are differences in fertilizer treatments within the range studied.

In Alfalfa Variety Test No. 2, 19 strains were seeded in 1928. The seasons' work on this test support the results from Test No. 1. A third test field of alfalfa varieties was started in August 1929. This is part of the extensive testing of legume varieties being conducted by this Station in cooperation with the Bureau of Plant Industry of the United States Department of Agriculture.

Tests of Varieties of Soy Beans and Field Peas. (A. B. Beaumont and R. E. Stitt). Twenty varieties of soy beans were grown from seed furnished by the Bureau of Plant Industry. Dunfield, Illini, Medium Green, Harbinsoy, Ito San and Habaro produced the largest yields of hay, but there were big differences in the quality based on size of stem. Large differences were also obtained in yield of seed, habit of growth, and other characteristics.

Five varieties of Canada field peas were grown. Planting time was delayed on account of the heavy rains of May. The plots were abnormally weedy and results are of little significance. Chang and Wisconsin produced the most hay, and O. A. C. 181 and Wisconsin the most seed to the acre.

The Value of Cover Crops for Onions. (J. P. Jones and M. E. Snell). The work on this project was begun in 1925. The plan has been to seed several cover crops on different plots at the last shove-hoeing and by comparison with adjacent plots without cover crops determine the effect on yield and quality of onions. Four years' records are now available. Considering the average effect on yield, red clover and rye appear to have been injurious, while crimson clover, timothy and redtop have been without effect. In 1928 and 1929 crimson clover and redtop increased the yield by 19 and 14 per cent respectively, but this was offset by decreased yields in the two previous years. A more consistent positive response is necessary before any of the cover crops thus far tested can be recommended as having a favorable influence on the yield and quality of onions.

Sulfate versus Muriate of Potash for Onions. (J. P. Jones and M. E. Snell). To answer the question frequently raised by growers as to the relative merits of sulfate and muriate as sources of potash for onions, the Station has conducted a comparative test of these two materials during the past four years. Summarizing the results for the entire period of the experiment, sulfate of potash gave an average yield of 137 bags per acre, while muriate gave 136 bags. In 1929, the year in which the onions were least affected by troubles such as blast, 242 bags per acre were obtained with sulfate of potash as contrasted with 250 bags with muriate, an insignificant difference. From the standpoint of growth of onions, it appears to make little difference which of these two forms of potash is used. In case of planning to grow tobacco on the land in the near future, it is perhaps best to fertilize with sulfate of potash to avoid any harmful effect on the burn of the tobacco frequently attributed to the chlorine carried by muriate of potash.

Lime in Relation to Onion Growth. (J. P. Jones and M. E. Snell). The experiments conducted during the past five years have shown lime to be almost indispensable in the successful growth of onions on acid soils. This has been demonstrated both on the Experiment Station farm and on several farms in the Connecticut Valley. The average of four years' results on the Experiment Station farm showed an increase of about 70 per cent in yield of No. 1 onions. Two tons of lime per acre have been about as effective as higher applications. In the last two years there has been a decline in the percentage response to lime. For instance, in 1926 and 1927 an increase of 87 and 96 per cent, respectively, was recorded for two tons of lime per acre, while in 1928 and 1929 the increase was only 51 and 33 per cent. Since the application was made five years ago, these results might indicate an exhaustion of the lime. On the other hand, this same trend is evident on the plots which received seven tons of lime per acre, and it scarcely seems possible that lime should be lacking with so large an initial application, even at the end of five years. The difference is believed to be due to a variation in seasons. In 1928 the blast hit the onions quite early, before the bottoms had begun to show appreciably. The tops were killed rapidly, and the injury seemed to be equally severe on limed and unlimed plots. The limed plots produce bulbs earlier and hence have an advantage when the blast occurs some time after bulbs have begun to form, as was the case in 1927; but in 1928, with the blast appearing just about at the beginning of bulb formation,

this advantage was greatly minimized. In 1929, however, there was no blast, and differences in earliness of bulb formation were not so important because quite favorable growing conditions prevailed throughout the season, allowing ample opportunity for the bulbs on both the limed and unlimed plots to mature. While 33 per cent increase in 1929 on the limed plot seemed small in comparison to that of previous years, the actual increase in yield per acre was approximately as large as any yet obtained.

When it was recognized that considerable lime must be added to acid soils to grow onions satisfactorily, there was some apprehension that severe damage might result through black root-rot injury should the grower wish to plant the ordinary strains of tobacco on his highly limed onion land. The Station therefore undertook some experiments looking toward the successful growth of onions at a soil reaction sufficiently acid to prevent any serious injury by black root-rot in case tobacco was grown later. Superphosphate has been credited by the Rhode Island Experiment Station and others as having an effect on acid soils, similar in some respects to that of lime. Large applications of superphosphate, alone and in combination with small amounts of lime, have been tried for the last two years. There is evidence that 500 to 1000 pounds of agricultural lime per acre in combination with 600 to 1000 pounds of superphosphate in addition to that in the regular fertilizer may be as effective as two tons of agricultural lime; but superphosphate alone, even in large applications, has not given satisfactory results. It has also been learned in this connection that onions can be grown satisfactorily at a reaction of pH 6.0. If the lime used in growing the onions has not raised the pH above this point, little injury may be expected from black root-rot should tobacco be grown on the land subsequently, especially if the soil is well drained.

Fertilizer Ratios for Onions. (J. P. Jones and M. E. Snell). This experiment was begun in 1925 with the idea of getting some estimate (1) of the relative amounts of nitrogen, phosphorus, and potash required by onions, (2) of the merits of fractional application of nitrogen, and (3) of the value of organic forms of nitrogen. All fertilizers have been applied at the rate of 2500 pounds per acre. The results at present show that increasing the phosphorus without at the same time increasing the potash is unprofitable. For instance, the 4-12-4 has given no better results than the 4-8-4, but the 4-12-8 has given an average increase of 18 per cent in yield over the 4-8-4 during the past four years. However, in 1929 the 4-12-8 did not give appreciably better results than the 4-8-4 or the 4-12-4, the large average increase being due to the large difference obtained in the three previous years.

The data on the amount of nitrogen indicate that a fertilizer carrying 4 per cent ammonia, applied at the rate of 2500 pounds per acre, will provide adequately for the first application. If necessary more nitrogen can be added later as a top-dressing, either in the form of fish or of nitrate of soda. Increasing the ammonia from 4 to 6 per cent by top-dressing has improved the yield by about 12 per cent over applying the entire 6 per cent in the first application of fertilizer. It is interesting to note that during the dry season of 1929 top-dressing with fish gave no increase in yield, while top-dressing with nitrate of soda gave a 13 per cent increase.

The 4-12-8 was used in the comparison of organic and inorganic forms of nitrogen. On one set of plots 50 per cent of the nitrogen applied came from tankage, 25 per cent from nitrate of soda and 25 per cent from ammo-phos; on the other set, about 20 per cent of the nitrogen was from calcium nitrate and the remaining 80 per cent from ammo-phos, both inorganic forms of nitrogen. With these materials differences were obtained which indicate that having some of the nitrogen in an organic form is preferable. However, the use of other sources of nitrogen might show the difference between the organic and inorganic forms of nitrogen to be less significant.

Onion Breeding. (J. P. Jones and M. E. Snell). The onion breeding work was continued in 1929 along the same line as reported last year, with major emphasis on selecting, inbreeding and mass breeding several strains of the yellow globe and Japanese set onions. In cooperation with G. B. Snyder, some effort was made to test a number of other varieties in addition to the yellow globe. This phase of the work should be pushed more vigorously during the coming year.

Influence on Onions of Rate of Seeding and Spacing Between Rows. (J. P. Jones and M. E. Snell). It was observed during the season of 1928 that the severity of the injury resulting from blast was greatly influenced by the thickness of the stand of onions. As a part of the studies made in connection with the blast problem, an experiment was laid out in 1929 to determine definitely the extent to which thickness in the row and space between the rows affected blast. There was no blast in the summer of 1929; hence nothing was learned regarding this. It was, however, possible to observe how such differences in planting affected yield and quality of onions in the absence of disease. Seeding at the rate of 3.5 pounds per acre impaired the yield out of proportion to the improvement in quality; seeding at the rate of 6.8 pounds per acre increased the yield, but not sufficiently to counteract the effects of reduction in quality. Rows 13 inches apart were found to give larger yields than those 15 or 18 inches apart, and there was little difference in quality. With seed showing a germination of 99 per cent as this did, it was concluded that for practical conditions seeding at the rate of between 4 and 5 pounds per acre, in rows 13 inches apart, will give the best returns.

In this experiment, as well as in some of the other onion experiments, counts were made of the number of plants per foot of row about the first of August. It was estimated from these data that only about 50 per cent of the seed planted actually produced plants that are likely to mature.

Relation of Aluminum Compounds to the Ill Effects of Certain Crops when Grown in Rotation. (J. P. Jones and M. E. Snell). This project includes the rotation and cover crop experiments and also that dealing with the specific effects of other crops on tobacco. In 1929 the work was redirected, looking toward a better understanding of some of the unusual results obtained with rotations. Among other things, consideration has been given to the possible relation of aluminum compounds to the depressing effect of some of the preceding crops on the yield and quality of tobacco.

Field results:—The results in 1929 were not greatly different from those

of previous years. The animal husbandry rotation consisting of corn, hay, and tobacco (the tobacco following hay) again produced a very poor crop of tobacco. The first four years timothy alone was seeded in the corn for hay, but during the last two years the plots have been divided, with timothy on the west and clover on the east halves of the plots. It was thought that the clover might improve the growth of tobacco in this rotation, but on the contrary the tobacco has been poorer after clover than after timothy two years in succession, 1928 and 1929. The tobacco was fertilized with 3500 pounds per acre of a 5-4-5 fertilizer mixture and approximately 10 tons of manure,—a more liberal treatment than was given the continuous tobacco plots which yielded satisfactorily. Corn in this rotation has generally grown well; but the timothy hay, although adequately top-dressed with fertilizer, has always been more or less of a failure. Clover, on the other hand, has grown vigorously, yielding in some instances double the amount of hay obtained from timothy.

In the cash crop rotation consisting of potatoes, onions and tobacco (tobacco following onions), the tobacco has always been superior to that produced in the animal husbandry rotation but not usually comparable to that grown in continuous culture. In 1928 the tobacco in this rotation yielded about as well as that on the continuous no-cover plots, but in 1929 the comparison was less favorable. The onions have never been especially successful, while the potatoes have been good in some years and poor in others. In 1929 a low yield of both onions and potatoes was obtained.

The comparison of timothy, redtop and rye as cover crops for tobacco was made again in 1929. The results for the past year showed timothy to be as satisfactory as either redtop or rye, and the yield of tobacco to be about as high as that on the plots without a cover crop. During the four years tested, redtop and rye have both given as good yields of tobacco as the no-cover plots. Timothy, on the contrary, has depressed the yield of tobacco three years out of six, but during the last three years it has given results just about as good as the no-cover plots.

The plots treated with manure in addition to the commercial fertilizer produced a very satisfactory crop during the season of 1929. Taking the six-year records available from these plots, very slight superiority can be claimed for the manure in comparison with a regular tobacco fertilizer. It has, however, been possible to reduce the fertilizer about 25 per cent without impairing the yield or quality of the tobacco. In response to requests from growers, the plots were divided in halves in 1929 and a sawdust stable manure was compared with the well rotted manure from the Station stables. The sawdust manure was obtained from the Quonquot stables where sawdust is used exclusively and liberally for bedding. This manure when in a pile looked more like sawdust than manure. The tobacco grew about equally well on the two types of manure. No injurious effect was noted from the sawdust. One year's results are not sufficient, however, to make any claims about the use of this manure year after year.

Tobacco after corn grew quite vigorously in the season of 1929 but yielded only 1692 pounds per acre in comparison with 1785 pounds after hay and 1890 pounds after tobacco. After onions and potatoes the yields

were about the same but somewhat lower than after corn and hay. This is an unusual result because in previous years better yields have been obtained after onions and potatoes than after corn and hay.

In 1929 brown root-rot affected the roots of the tobacco but slightly on the cover and no-cover crop plots but did injure the roots of the tobacco in rotation with corn and hay very severely and to a less extent than in rotation with potatoes and onions.

In the greenhouse, with water cultures, aluminum has been found to produce an effect on tobacco roots similar to that of brown root-rot in the field. Thinking that aluminum in the soil might be a factor in causing brown root-rot in the field, treatments were made on the rotation plots to eliminate any effect of soluble aluminum. These treatments consisted of large applications of superphosphate, which experiments at other stations have proven to be successful in counteracting the injurious effects of aluminum. The results were not particularly encouraging. Brown root-rot was just as severe where the superphosphate treatments were made as where they were not. The yield was not increased by the superphosphate, which is contrary to experience with similar treatments on other plots in the absence of brown root-rot. It might be said from this year's experience, if it can be assumed that superphosphate renders soluble aluminum inactive, that the brown root-rot found in the field is not caused by an excess of soluble aluminum, and that it is a different type from that observed in the greenhouse water cultures as resulting from aluminum injury.

Soil nitrate determinations were made during the growing season of 1929 to see whether plowing under carbonaceous residues had reduced the available nitrogen, as found by other experiment stations. The data obtained are in agreement with those of previous years in showing no case where the residues turned under in the rotations have reduced the available nitrogen to the point where it limited the growth of tobacco.

Quantity of Nitrogen and Phosphorus for Tobacco. (J. P. Jones and M. E. Snell). The phase of this experiment dealing with the amount of nitrogen required in growing tobacco was started in 1926. The recommendations which seem justified from work on the experimental plots to date are: (1) In the absence of barnyard manure, 150 pounds of ammonia per acre is the minimum that should be considered in fertilizing tobacco; (2) a somewhat better yield has been obtained each year with 200 pounds of ammonia per acre than with 150 pounds, and for many fields the larger application may be nearer the optimum; (3) although in previous years 250 pounds of ammonia per acre produced slightly superior yields, in 1929 it gave no better yields than the 200-pound treatment; and it has been concluded that this large application will prove profitable only in unusual situations.

Among the observations made on tobacco, it was noted that the reduction in growth due to the deficient nitrogen was always apparent before the typical yellow color signifying nitrogen starvation. In 1928, a rainy season, the yellow color was found much earlier than in 1929, a dry season. Although reduced growth could be seen readily on the low nitrogen plots in 1929, yellowing of the leaves was scarcely perceptible even at the time of harvest.

In the experiments with quantity of phosphorus, attempt has been made to measure the stimulative effect on the growth of tobacco of large applications of superphosphate, rather than to determine the optimum nutrient requirement of tobacco for phosphorus. During the first season, 1928, when one-half, one, two, and four tons of superphosphate per acre were applied in addition to that in the regular tobacco fertilizer, notable increases in yield were obtained, the maximum being from the two-ton treatment. In 1929 much larger yields were obtained, but there was no response to the excessive applications of superphosphate. In another experiment, however, the yields were markedly stimulated by four tons of superphosphate. A very interesting feature of these experiments has been the observation on maturity. Contrary to what is generally expected from excessive applications of phosphorus, there has been no evidence that the tobacco has matured unusually early or any differently from that not receiving the extra phosphorus.

The Magnesium Requirement of Certain Common Crop Plants. (J. P. Jones and M. E. Snell). This experiment was started in the season of 1929 and is a redirection of previous work which had shown a magnesium deficiency in the soil of one of the old experimental fields at the Station, illustrated by certain symptoms on both corn and tobacco. The work as now outlined consists of an attempt to observe the symptoms of a lack of magnesium on several of the commonly grown crops, such as onions, clover, timothy, alfalfa, and potatoes. The season was too dry in 1929 to permit a satisfactory growth of these crops; hence the observations made are not considered sufficiently satisfactory to draw conclusions at this time. It has also been proposed in connection with this work to make some chemical studies of this and other soils, hoping to account more definitely for the lack of magnesium. Progress is being made on this phase of the work, but no results can be included in this report.

DEPARTMENT OF BACTERIOLOGY AND PHYSIOLOGY

G. E. Gage in Charge

Nitrogen-Fixation in Relation to Legumes and Non-Legumes under Defined Agronomic Conditions. (James E. Fuller). This project has been followed out as outlined for the last year: namely, to study soils of different units to determine the ability of these units to fix atmospheric nitrogen; to isolate organisms from the units and study the distribution of nitrogen-fixation organisms as compared with the nitrogen-fixation power of the soil units; and lastly, to study factors which may influence the presence and activity of nitrogen-fixing organisms isolated in the studies. The preliminary phase of this project has been completed and has been written up and accepted for publication by *Soil Science*. It will appear in the next May or June issue of that journal. The first part of this study was carried on by Dr. Leon A. Bradley and was taken over in 1928 by Dr. James E. Fuller. A summary of this preliminary investigation as carried out on an experimental field (Field A) divided into twenty-four plots, has furnished the following information.

Four definitely planned experimental conditions were established for the defined agronomic work:

1. Units planted with legumes and receiving fertilizer.
2. Units planted with legumes and not receiving fertilizer.
3. Units receiving fertilizer but not planted with legumes.
4. Units not receiving fertilizer and not planted with legumes.

From this summary there appears to be sufficient nitrogen-fixation in the soil of Field A to account for the nitrogen reserve. The nitrogen-fixation in the experimental field is correlated with the presence of a strain of *Azotobacter* capable of fixing substantial quantities of nitrogen when cultivated in pure culture in a nitrogen-free medium. Nitrogen-fixation and the distribution of the *Azotobacter* appear to have remained reasonably constant over a three-year period. The growth of the legume and non-legume crops has not influenced nitrogen-fixation or the distribution of the *Azotobacter*. The hydrogen-ion concentration of the soil of the experimental field does not appear to be the controlling factor in the nitrogen-fixation or the distribution of the *Azotobacter*. The data as accumulated in this study have furnished considerable information which may later be placed on a basis for the establishment of practical methods by which the nitrogen-fixation organisms *naturally present in soil* may be stimulated to greater activity.

Laboratory Service. (Ralph L. France). More than one thousand examinations of samples were made by the department during the past year. Of this number, seven hundred were control tests of various town milk supplies in the Connecticut Valley. In many cases monthly control tests are made, and in other cases the testing is done at different times during the month. At the present time the activities in this phase of the laboratory work are somewhat limited because samples can be transported only short distances. Then, too, the Massachusetts State Department of Health carries on activities especially for those dairies and town health departments located in the Boston or metropolitan district. Many samples from private water supplies have been submitted to the laboratory for examination. These have been for complete bacteriological and chemical examination, for the most part, to determine the purity of the water in question. It is of some interest to us from the standpoint of public health to note that nearly 50 per cent of the private supplies were found to be unsafe. This indicates the need of more active education in the construction and location of private water supplies. It also indicates the need of a sanitary survey of water supplies as regards those located on private property.

The sale of legume cultures has materially decreased during the year. This is no doubt due to the activities of certain commercial concerns which are supplying cultures free to purchasers of legume seeds in bushel lots.

Other services rendered by the laboratory are:

1. Bacteriological analyses of food and food products, milk and milk products, and water.
2. Chemical analyses of milk and water.
3. Preparation and distribution of viable and efficient cultures of nitrogen-fixing bacteria for leguminous crops.
4. Testing of nitrogen-fixing bacteria for quality.

5. Bacteriological examinations concerning sewage disposal.
6. Bacteriological examinations of swimming tank waters for purity.

Studies on the Indol Tolerance of the Colon-Aerogenes Group of Bacteria as a Possible Means of Differentiating Fecal and Non-Fecal Strains Occurring in Drinking Water Supplies. (Ralph L. France). The results to date are very promising and it is hoped that the study will supply a more accurate method of testing water for fecal contamination.

The laboratory is now in its second year of service and the indications are that it is well established and conducted for the kind of work assigned to it. This type of supplementary investigational program will aid materially in the value of the service.

DEPARTMENT OF BOTANY

A. Vincent Osmun in Charge

Tobacco Diseases. (W. L. Doran).

Black Root-Rot. A paper on the effects of soil temperature and reaction on growth of tobacco infected and uninfected with black root-rot has been accepted for publication in the *Journal of Agricultural Research* for December 1, 1929.

In the field experiments, the pH values of soil in limed plots have remained practically unchanged at about 6.0 for the past four years. Neither alfalfa nor timothy, grown two seasons on limed plots, has resulted in soil significantly more acid than has continuous tobacco. Of the acidifying treatments of limed soil, the most effective were sulfuric and orthophosphoric acids applied together in two successive years, and sulfur (400 lbs. per acre) applied in two successive years. The application of any of these treatments in only one year (1926) had but slight effect, if any, on soil reaction after 1927. Examination of roots indicated that black root-rot in these plots was suppressed in proportion to the effectiveness of the acidifying applications.

Yields on unlimed plots without acidification and with tobacco grown continuously were 28 per cent greater than on limed plots (last limed in 1923). Yields on limed plots were increased by all the acidification treatments as compared with yields on limed plots without acidification. Sulfur (200 lbs. per acre) applied in 1926 and 1927, and sulfuric and orthophosphoric acids applied together in the same years gave the greatest increases.

Investigation of the use of various chemicals for the prevention of black root-rot and other soil-borne diseases of tobacco seedlings has continued. Acetic acid treatment of the soil was tested in several commercial seed beds. In every case the treatment resulted in suppression of weeds and successful control of both damping-off and black root-rot. It compared favorably with steam sterilization against which it was checked.

Tests with monochloroacetic acid were not encouraging. Interesting and promising results were obtained with pyroligneous acid. Experiments were conducted with the object of adding to our knowledge of the effect of

soil conditions on the efficiency of acetic acid and formaldehyde as soil disinfectants.

Study was made to determine whether the inhibiting effect of acid soils on *Thielavia basicola* may be directly due to some other factor than hydrogen-ion concentration, more especially active aluminum. Results indicate that aluminum sulfate is about as effective as sulfur and sulfuric acid in acidifying soil and in suppressing the black root-rot fungus.

Earlier experiments indicated that phosphoric acid is markedly favorable to the parasitism of *Thielavia basicola* and that its influence may be as great as that of soil reaction, or greater. The effect of this chemical on black root-rot, growth of tobacco, and soil reaction is now being studied in a new series of pot experiments.

Brown Root-Rot. Field studies have continued on the plots originally planned for investigation of black root-rot. In general, there was practically no brown root-rot on plots in continuous tobacco since 1921; some brown root-rot occurred wherever tobacco followed either timothy or alfalfa, but was somewhat more severe in limed plots following timothy. The presence of brown root-rot was generally accompanied by reduction of yield, but a constant relation between disease and yield was not always found.

On the theory that timothy sod is injurious to tobacco because of the large amount of cellulose and the low amount of available nitrogen present, Johnson and coworkers of the Wisconsin Station recommend applications of nitrogen where tobacco follows timothy. In order to determine the effect of nitrate (calcium nitrate), and the time of its application to timothy sod, on tobacco and on brown root-rot, a series of pot experiments was conducted. From these it may be concluded that heavy applications of calcium nitrate to timothy sod reduce the severity of brown root-rot; and that the nitrate increases growth much more when applied to brown root-rot soil than when applied to soil which does not contain the cause of brown root-rot.

Assuming a hypothetical relation between brown root-rot and activities of soil organisms resulting in a lack of nitrogen or in the formation of substances (undetermined) toxic to tobacco, it would seem possible that certain inorganic salts applied to the soil might affect the disease through their toxicity to the organisms or by chemically inactivating certain toxic substances. Experiments based on this theory are under way, but it is too early to report definite results.

Control of Diseases of Greenhouse Vegetables. (E. F. Guba, Waltham).

Leaf-Mold of Tomatoes. Work on this disease during the last year has been concerned mainly with house management as a means of control. The conidia of the causal fungus germinate at a relative humidity of 100 per cent, which in the greenhouse is attained on the leaf surfaces when the atmospheric humidity is above 85 per cent. Proper adjustment of air circulation, water and heat is necessary to maintain conditions unfavorable to conidial germination, and this ordinarily involves much labor and attention by the operator. In this investigation equipment for the automatic control of temperature and humidity has been employed. In the light of knowledge previously gained in laboratory study of the causal fungus and observations in the greenhouse, a set of house management

practices was evolved to provide proper conditions for the control of leaf-mold. Experiments were conducted for comparison of "good" and "bad" growing conditions as related to control of the disease. Proper management resulted in decreasing leaf infection about 70 per cent and yield of fruit was increased 18 per cent.

Downy Mildews of Cucumber and Lettuce. (W. L. Doran). The first appearance of downy mildew on cucumbers in the field was recorded on August 19, only a few days later than for the last five years,—and this despite the extremely dry summer, in which neither onion nor potato mildew was observed in this-region. The disease was no less severe in some fields where cucumbers had not been grown for at least three years previously than on fields where cucumbers were affected with the disease last year.

Lettuce mildew rarely occurs in the field here except in cool weather in fall. Attempts to maintain the fungus on infected plants (Belmont variety) set in the field in May failed, probably because of the warm, dry weather. Observations indicate that high air temperature constitutes an important natural defense against this disease in the field.

In the greenhouse, work continued on the relation of management and the use of fungicides to the control of these diseases. Experiments to determine whether potash and lime applied to the soil tend to decrease susceptibility of cucumber plants to attack by downy mildew produced only negative results.

Pseudoperonospora of cucumber and *Bremia* of lettuce were successfully grown for several weeks on detached cotyledons of host seedlings floated in a 5 per cent solution of sucrose in Petri dishes. It is thus possible, by occasional transfers, to maintain these fungi when conditions in the greenhouse do not favor their growth.

Study of over-wintering of downy mildew of cucumber added nothing to previous knowledge of this phase.

Eradication of Nematodes in Greenhouse Soils. (L. H. Jones). Work previously reported has shown that a combination of acetic acid with calcium cyanide will eradicate nematodes. Of considerable importance is the fact that two treatments with this combination must be used, with an interval of about seven days between the treatments. The rôle of the acetic acid in the combination chemical is apparently that of a carrier for the lethal cyanide. The effect is to maintain the fairly volatile cyanide gas in the soil much longer than it would ordinarily persist if the acetic acid were not used. If this same principle could be applied by using a dry chemical in place of the liquid acetic acid the idea would have a better opportunity for adoption in agricultural practice. Paradichlorobenzene, the P. D. B. used in eradicating peach borers, seems to fulfill the same rôle as acetic acid. It is a dry chemical and when mixed with calcium cyanide the combination remains a true mixture. There is no caking and once a uniform mixture is attained it remains as such. One treatment with this combination reduces the numbers of nematodes considerably, but eradication is not obtained unless two treatments are used with an interval of one week between applications. The use of the paradichlorobenzene with calcium cyanide has been tried by varying the proportions of each chemical and also the amount applied. In general the results indicate that

a 1:1 ratio is the best, and three grams of the mixed chemicals for a six-inch pot of soil proved the most efficient rate of application. Before this method can be demonstrated on a commercial scale, there are certain problems that must be solved by the laboratory method.

Eggplant Wilt. (E. F. Guba, Waltham). Addition of chemicals to the hills at planting time, with the object of sterilizing the soil about the roots, gave no control of the wilt disease. Negative results were also obtained with the use of a paper mulch. Studies in several fields of the New York Purple variety indicate that the eggplant tolerates a high degree of soil acidity, and that this condition usually is accompanied by an insignificant amount of wilt. These findings point to the changing of soil reaction as a means of controlling wilt, and efforts are being directed toward this objective.

Onion Blast. Several departments cooperated in work on various phases of the problem presented by the disease of onions known as *blast*. A field survey and spraying and dusting experiments were conducted by A. I. Bourne (Department of Entomology) and W. L. Doran (Department of Botany). Weather conditions were unfavorable to the development of blast, and the trouble did not occur. Drought injury and thrips injury were severe in many fields. Because of the absence of blast and downy mildew, no data were obtained on the effect of dusts and sprays on these diseases. The joint effects of chemicals and mechanical injuries were such that it was concluded safe to spray six times with 4-4-50 Bordeaux, but not nine times; three times with 8-4-50 Bordeaux, but not five times; and six times with milk of lime, but not nine times. Copper-lime dusts proved more injurious than any of the Bordeaux mixtures.

L. H. Jones (Department of Botany) worked on the physiology of onion blast. Growing onions under conditions of reduced light and high humidity tended to reduce root growth and to produce tender tops. Subsequently, when exposed to hot sunshine and drying wind, these plants were injured in a manner resembling the condition known as blast.

Carnation Blight. (E. F. Guba, Waltham). The toxicity of fungicides to spores of the causal fungus (*Alternaria dianthi* S. & H.), the prevention of infection of potted plants which were artificially inoculated with spores of the pathogene, and the control of the disease in the field have been studied. In the toxicity tests with spores, naphthalene dust proved the most effective of twelve fungicides employed. In an experiment on the prevention of infection, five fungicides were used, each applied alone and in combination with fish oil. Calcium arsenate with fish oil and Bordeaux mixture with fish oil gave the best results. Results of a second experiment substantiated those of the first and indicated no advantage in the use of saponin as a spreader. Thirteen distinct treatments were compared in a spraying experiment in the field. Bordeaux combined with calcium arsenate and fish oil was the most effective of the fungicides used. Copper-lime dust and calcium arsenate proved the least effective. Calcium arsenate, alone or in combination with lime-sulfur, caused injury to the plants.

Forcing Gladiolus with the Aid of Artificial Light. (L. H. Jones). The embryonic flowers of the gladiolus are formed a few weeks after the corms are planted. Under normal out-of-door cultural conditions this

period would be during the longest daylight exposures of the year. A preliminary pot experiment indicated that a marked increase in bloom could be obtained by supplementing the daylight of late fall and early winter employing 100-watt electric light bulbs.

An experiment based on this light factor in which four plots were used was set up in January, 1929. Black curtains separated the plots receiving artificial light from those receiving no artificial light at night. In each plot 195 corms were planted and a careful record was made of the number of flowering spikes and the number of flowers on each spike. The results showed that light had caused an increase of 63 per cent in the number of spikes and an average increase of 30 per cent in the number of flowers on a spike.

The time of year has considerable influence on the time interval from planting to flowering, and this time interval is increased by the use of artificial light. In these experiments artificial light retarded the date of flowering by approximately fifteen days.

The variety *Crimson Glow* was used in conducting this investigation.

Influence of Light Quality on Plant Growth. (A. V. Osmun). Preliminary experiments have been conducted to test the effect of so-called health glass (glass which transmits a considerable percentage of the ultra-violet rays) on plant growth and development. Plantings were made in a lean-to greenhouse in which one-half of the ordinary glass had been replaced by Vita glass. Radishes grown under Vita glass showed a gain of 71 per cent in weight of the entire plant and 124 per cent in weight of roots as compared with an equal number of plants grown under ordinary glass. Similarly, lettuce gained 76 per cent in weight and formed much more compact heads when grown under Vita glass. No consistent results were obtained with calendulas and pansies.

The Effect of Pot Structure on Soil Temperature. (L. H. Jones). A series of tests conducted with various types of plant containers has shown that the structure of the container has a marked influence on the temperature of the soil. The regulation three-inch standard clay pot will maintain a soil temperature as much as 20° F. below that of the air in a greenhouse on a hot day. On the other hand, a pot of vitreous material or a glass tumbler will maintain a soil temperature that lags only 1° or 2° behind the rise and fall of the air temperature.

Between these two extreme types of pots, the former very porous and the latter with no porosity, there are intermediate types of pots that maintain their soil temperatures according to the amount of moist area presented by the pot to the air in the case of the porous pots, or else the soil temperature will be influenced by the insulating value of the pot material in the case of the non-porous pots.

The cooling effect by evaporation of moisture from the outside of the pot persists as long as the pot is able to withdraw moisture from the soil to moisten its surface.

THE CRANBERRY STATION

(East Wareham, Massachusetts)

H. J. Franklin in Charge

Injurious and Beneficial Insects Affecting the Cranberry. (H. J. Franklin).

(a) Penetrol, an activating oil developed under the auspices of the Crop Protection Institute, was tried with nicotine sulfate and also with pyrethrum soap in tests to control the black-headed fireworm, with negative results.

(b) Dipple's oil was tested as a repellent against the cranberry fruit-worm moth, with negative results.

(c) The relationship of birds to cranberry pests was studied somewhat. Birds were killed and the contents of their digestive tracts examined.

(d) Entomogenous fungi parasitic on the black-headed fireworm were cultured and disseminated on cranberry bogs to test the possibilities of practical control of the fireworm by the use of these fungi. Dr. William H. Sawyer, Jr., was in charge of this work. Practicable methods for growing the fungi in quantity were developed, but the results of field dissemination were not successful enough to make this method of control seem very practicable.

(e) Japanese beetle traps and baits were tried against the cranberry root grub beetle, with mostly negative results.

(f) The life histories of the cranberry black bug (*Plagiognathus repetitus* Knight) and the false blossom leafhopper (*Euscelis striatulus*) were studied.

(g) Various kinds of fish were tested as possible water indicators to be used when flooding cranberry bogs to determine readily when such flooding has become dangerous. This study gave very promising results. Dr. H. F. Bergman was in charge of this work.

(h) Profitable studies were conducted on the distribution and habits of the cranberry white grub (*Phyllophaga anxia* Lec.).

(i) Spray tests against the false blossom leafhopper, with nicotine sulfate and with pyrethrum soap, brought out very clearly the fact that the latter controls the pest much more effectively than the former, while the two insecticides used together caused considerable injury to the vines.

Cranberry Disease Work. (H. J. Franklin in cooperation with the Bureau of Plant Industry, U. S. D. A.). Dr. Neil E. Stevens of the Bureau of Plant Industry was at the Cranberry Station during much of the growing season and cooperated actively as usual in this work.

(a) Final and conclusive proof was developed that the false blossom disease is carried freely from diseased to healthy vines by the leafhopper (*Euscelis striatulus* Fall.) This is very important and should lead shortly to a much better control of this serious disease than has been achieved in the past. Other experiments gave little evidence, if any, that the cranberry black bug, cranberry spittle insect, sharp-nosed leafhopper (*Platymetopius magdalenensis* Prov.), or springtails (Collembola) have anything to do with the spread of the disease. The history of the spread of this disease in Massachusetts was given further careful study to make it as complete as possible.

(b) Dr. Stevens continued and extended his studies of the relationship of weather to the keeping quality of the fruit, and his incubator tests of keeping quality.

(c) Dr. Stevens made studies of the relative thickness of the cuticle of the berries of many different varieties to see if this showed any correlation to varietal disease resistance. The study gave negative results which were, nevertheless, highly significant and of great importance.

Weather Observations with Reference to Frost Prediction. (H. J. Franklin in cooperation with the U. S. Weather Bureau).

(a) Reports of local weather observations made at 8 a.m. (Eastern Standard Time) were made daily by telegraph to the office of the Weather Bureau at Boston. General weather observations were made and recorded at 8 a.m., noon, and 8 p.m. and were reported on a card form to Boston daily.

(b) Further weather records likely to have a bearing on frost forecasting were accumulated from observing stations in North Harwich, East Wareham, Carlisle, Holliston and Worcester, as well as the regular cranberry observing stations at Marstons Mills, South Carver, Norton, Halifax, South Hanson, and Pembroke.

(c) Studies of observations already recorded yielded important new knowledge on this subject, making possible further definite improvement of the formulae for computing temperature minima. In the formulae thus modified, the dew-point and the reading of the wet bulb thermometer are the significant data mathematically combined.

(d) Forecasts of minimum bog temperatures were made in the frost seasons at noon and at 7 p.m. (Eastern Standard Time). These forecasts were distributed by the New England Telephone & Telegraph Company as heretofore, the cost of distribution being paid by the Cape Cod Cranberry Growers' Association.

Varieties. Dr. Sawyer made hydrogen-ion determinations of the foliage of many of the cranberry varieties at different times of the day and night and of the growing season. It was thought that this work might show a correlation between pH values and productiveness or disease resistance in cranberry varieties; but while the pH of the different varieties showed interesting variations, no very certain correlation of this kind was disclosed.

DEPARTMENT OF DAIRY INDUSTRY

J. H. Frandsen in Charge

A Study of Packaged Ice Cream. (K. E. Wright). This project has continued uninterruptedly during the year. Much work has been done as a check on preliminary conclusions reported in the last Biennial Report. Research work has also been done on several other phases of this problem. Considerable study has been made in an effort to determine just why a maximum drawing temperature of 25.5°F. seems necessary in the case of a 12 per cent fat, 10 per cent serum solids, 15 per cent sugar, and .45 per cent gelatin mix. A study of the rate of cooling samples drawn from the freezer at various temperatures indicated no difference as far as evolution of heat fusion and crystal formation are concerned.

From a study of the effect of aging on the texture of ice cream, the following conclusions have been drawn:

1. A high initial temperature in the aging period of the ice cream mix favored the development of greater basic viscosity.
2. The maximum viscosity was found to be imparted when the mix was held at a temperature of 80 to 100°F. for two to four hours, without agitation.
3. The whipping property was decreased as the viscosity increased.
4. The rate of melting was decreased as the viscosity increased. The manner of melt-down was also influenced by difference in viscosity.
5. The texture was improved as a result of greater viscosity development.
6. The influence of aging in ice cream has been attributed largely to the factors affecting crystallization of the gelatin portion of the product on the basis of the data obtained.

The Quinhydrone Electrode in the Dairy Laboratory. (Work started by A. W. Phillips and now conducted by K. E. Wright.)

Further study indicates that since different kinds of milk bacterial flora function in different ranges of pH, and since milk has a relatively high buffer value and perceptible changes in pH do not take place with appreciable additions of acid or alkali, the quinhydrone electrode determination of pH cannot be used for determining accurately the keeping quality of milk. This work agrees with conclusions reached by A. W. Phillips.

The Utilization of Frozen Fruits in Ice Cream. (M. J. Mack). This project, now in its second year, is being conducted in cooperation with the Department of Horticultural Manufactures. Fruits made available in a study of cold packing methods are being used in the manufacture of fruit ice cream.

The varieties of fruits which were found to be most satisfactory for freezing are likewise superior for use in ice cream. The optimum percentage of fruit in fruit ice cream was found to be approximately 15 per cent for cold packed strawberries; 8 to 10 per cent for raspberries, plus a suitable amount of raspberry extract; 15 to 20 per cent for peaches in combination with an extract; and 12 per cent for cherries. The desirable ratio of fruit to sugar in the pack used for ice cream making was found to be 2:1 and 3:1 for cherries and strawberries, and 3:1 for raspberries and peaches. Fruit frozen without sugar or with corn sugar as a substitute for cane sugar was unsuitable for use in ice cream.

The fruit should be added to the ice cream directly after the freezing operation is started in order to insure the maximum of fruit flavor and even fruit distribution as well as more rapid freezing and whipping of the ice cream. Fruit ice creams have a lower freezing point than plain ice cream and should be drawn from the freezer at a temperature at least 1 to 1.5°F. lower than is necessary for plain ice cream. Fruit ice creams cool faster in the freezer, whip faster, and require a shorter time of brine flow than does plain ice cream made from the same basic mix.

A Study of Frozen Sweet Cream for Use in Ice Cream. (M. J. Mack). Sweet cream of good quality can be stored satisfactorily in the frozen

state during surplus periods for later use in ice cream. Cream of low acidity will remain in good condition for several months if sufficiently low temperatures are employed; i.e., 0°F. or lower. Ice cream of desirable flavor can be made from frozen sweet cream provided not more than one-third of the fat content of the product is derived from this ingredient.

Ice cream mixes containing frozen sweet cream are high in viscosity, due in part to excessive clustering of the fat globules after homogenization. Frozen sweet cream has been found to be an overrun deterrent, such mixes requiring about 10 to 20 per cent more time to whip. An attempt is being made to find a method for storing sweet cream so that it can be used without increasing the mix viscosity and length of freezing. Data secured to date indicate that combining some of the gelatin or sugar with the cream previous to freezing will produce a resultant mix of lower viscosity and a more normal freezing time.

A Study of Electric Refrigerated Milk Cooling Tanks. (J. H. Frandsen and H. G. Lindquist.) Work on this project was started in the summer of 1929, the object being to determine the efficiency and cost of cooling milk in electric refrigerated cooling tanks. Several different makes of electric refrigerated units have been installed and data collected as to the length of time required to cool milk from 90 to 50°F., and the amount of current necessary to cool milk under ordinary farm conditions. The data thus far collected are not sufficient to warrant definite conclusions.

A Study of the Changes that Occur in the Storage of Frozen Sweet Cream. (H. G. Lindquist). Preliminary experiments have been made, but not enough work has been done to justify conclusions.

DEPARTMENT OF ENTOMOLOGY

H. T. Fernald in Charge

Dates of Hatching of Scale Insects and When to Spray* for Them. (A. I. Bourne). The necessary observations on critical stages in seasonal development of these insects and their correlation with climatic conditions for the past season have been recorded.

The scarcity of previous work along these lines gives almost no background of accumulated facts to assist in interpretation of results. This has necessitated observations over a long period, to determine accurately the influence of abnormal seasons.

It has been found that the variations in temperature in late fall and the severity of the following winter exert a great influence upon the rate of development of these insects.

The marked contrast in weather conditions in the years 1928 and 1929 has afforded unusual opportunity to determine the effect of such extremes, particularly upon the spring appearance of young scales in the single-brooded species, Oyster-shell Scale, and upon similar development in the summer generation of a two-brooded species, the Pine Leaf Scale.

Investigation of Materials Which Promise Value in Insect Control. (H. T. Fernald and A. I. Bourne). The chief attention this season has

been directed toward the comparative efficiency of different types of oil sprays for European red mite control, as well as checking them from the standpoint of safety to the trees.

Against a moderate infestation of red mite, almost all of the oils tested gave satisfactory control, indicating that in general, under such conditions, thoroughness of application and proper timing are more essential than the mere choice of oil spray.

In some cases, after conference with manufacturers, oils were applied at an advanced strength over that previously recommended, in order to meet Massachusetts conditions better.

The effect of combining certain types of oil sprays with sulfur or copper fungicides was studied, both from the standpoint of safety to the trees and of effectiveness against red mite. The results of these tests indicated that these oils can be so used, safely and without impairing their insecticidal value.

The abnormally high temperature in early April afforded opportunity to study the effects of oil sprays for delayed dormant application under conditions very unusual in Massachusetts. The burning which resulted pointed out the possibility of maximum temperature requirements for safe application of oil sprays in addition to the minimum limits with which Massachusetts growers are familiar.

A study of a recently developed sulfonated, oxidized oil spray was begun, particularly as to its possibilities as an activator for nicotine. Preliminary tests have shown that a dilution of one-half to one per cent, when combined with nicotine sulfate, gives satisfactory control of some insects, with concentrations of nicotine much lower than those at present recommended. This means a material reduction in the cost of such sprays which are at present relatively expensive.

Control of Onion Thrips. (A. I. Bourne). The summer of 1929 was characterized by conditions of severe drought. Such an abnormally dry season was very favorable for thrips development. Throughout the early summer the infestation was comparatively light and of little consequence. During July and August, when the effects of the continued drought became more pronounced, thrips increased rapidly and many onion fields suffered severely from the combined effects of thrips and dry weather. In the absence of blast and mildew, however, the plants on the whole remained green and vigorous considerably later than in the years when those diseases were prevalent. The period of abundance and activity of thrips was proportionally lengthened.

Some growers became interested in the possibilities of biological control of thrips, purchased a quantity of lady beetles from a western state, and liberated them in a field where thrips were abundant. The effort was not crowned with any conspicuous success. Examination of onion fields in the Valley, throughout the season, resulted in the collection of at least five different species of predacious beetles, all of them well established in this region. The beetles imported from the West belong to one of these species.

Field tests demonstrated the nicotine-soap combination to be an effective killing agent against thrips, and the machinery for application practicable. In cooperation with the Department of Botany studies were made

of the relative efficiency of combined sprays of nicotine and copper fungicides, for the control of thrips and blast or mildew, or both.

Preliminary tests were made of a new spray material designed to serve as an activator of nicotine, with the view of lowering the strength of the nicotine sulfate spray from present requirements without impairing its efficiency against thrips.

In cooperation with the Department of Botany, observations of onion fields in the Valley were made throughout the season to note the appearance and extent of blast and the correlation, if any, of this disorder with insect activities.

Control of the Plum Curculio in Apples. (W. D. Whitcomb, Waltham). High temperatures in May and June stimulated the beetles to make two to three times as many punctures per day as were observed in previous years. Parasitism was exceedingly low. Early in the season the number of punctures made in sprayed and unsprayed fruit was approximately equal, but two weeks later the beetles made 103 punctures in the unsprayed fruit and 12 in the sprayed fruit. Laboratory poison experiments again indicated that lead arsenate at the rate of 2 pounds in 50 gallons of water is the minimum dosage which should be used, and that calcium arsenate is superior to lead arsenate in equal units by weight. Fish oil sticker again increased the effectiveness of the poison but less than in previous years.

In confinement, beetles were attracted to and fed freely on dried fruit baits containing various poisons. However, preliminary trials with these baits in the orchard failed to show beneficial results, indicating that the method of exposing the baits needs further study.

Spray Residue Problem and Its Relation to Orchard Practices. (A. I. Bourne). Spraying and dusting experiments on the three standard varieties of apples, Wealthy, McIntosh, and Baldwin, were continued in 1929.

The experience of the past summer has demonstrated the very great influence which the type of season has upon the problem of spray residue on fruit at harvest. Compared with the two previous years, the rainfall in 1929 during the period between the calyx spray and harvest was relatively insignificant, as noted below.

	Rainfall—inches		
	1927	1928	1929
Wealthy	13.0	23.5	7.8
McIntosh	14.6	24.6	8.4
Baldwin	18.5	25.0	10.3

Under such conditions, much of the spray deposit normally removed from the fruit by rainfall persisted throughout the season. Consequently, sprays could not be applied after early summer with any assurance of safety, especially on Wealthy or McIntosh. On the other hand, even the late summer applications of sulfur—lead dusts on these same varieties were made without encountering any difficulties as to residue.

Biology and Control of the Carrot Rust Fly. (W. D. Whitcomb, Waltham). The general infestation by the first generation of the carrot rust fly was much less than in 1928 due to unfavorable conditions for oviposition; consequently injury by the second generation was also somewhat lighter.

Flies emerged from 92 per cent of the pupae confined in *slightly* moist sand and loam, and from 80 per cent of those in moist sand and loam, but from only 50 per cent and 33 per cent of those in wet loam and dry sand, respectively. Due to climatic conditions the flies emerged from 10 to 14 days earlier than in 1928. This condition continued through the summer and resulted in the emergence of thirteen third generation adults, the first observed at Waltham.

Preliminary studies were made with potted carrots grown from seed treated with mercury compounds. Where calomel was dusted on the soil as well as the seed, the plants showed 35 per cent less injury than plants from untreated seed. Plants from Semesan treated seed showed very little infestation.

Studies were made of the effect of different sprays on the adult flies. The relation of planting dates to percentage of injury by first generation larvae was also studied as well as relative susceptibility of different varieties.

Mulch paper effectively checked the first generation infestation, but the second generation damage was from 5 to 17 per cent greater under the paper.

Studies were made with insecticides and repellents. Some of the materials showed considerable promise, although the protection from second generation attack was somewhat less pronounced.

Systematic Study of Oil Sprays. (H. T. Fernald). The entomological part of the project during 1928-29 has been restricted mainly to conferences with the Department of Chemistry which is cooperating in the project, in order to keep in touch with the work done and to obtain a thorough understanding of the chemical processes made use of. It now seems probable that some of the materials desired for field tests may be available for this purpose the coming spring, and these tests will be made by the Department of Entomology.

FARM DEPARTMENT

Enos J. Montague in Charge

Intensive Grassland Management under the Hohenheim System. (E. J. Montague, C. H. Parsons and R. C. Foley). In the spring of 1928 an experiment in intensive grassland management, under the Hohenheim System, was put into operation. This originated in Germany during the World War and has since been used successfully in the Netherlands and the British Isles. It is designed to provide a luxuriant growth of grass rich in protein, thereby making it possible for the dairy farmer to produce on his own farm most of the feed necessary for his herd, at least during the summer months. On the College farm this system has greatly reduced the amount of concentrates fed in the summer and has yielded an average return per acre of \$69 a year from the plots to which complete fertilizer was applied, as compared with an average return of \$22 from the unfertilized plot.

The Hohenheim System is based upon four distinct principles: division

of the area into plots, combination of grazing and hay land, use of concentrated fertilizers, and rotational grazing.

About seventy-five acres of land that had formerly been in a crop and pasture rotation were divided and fenced off into nine equal plots. The first six were used exclusively for grazing. As checks, Plot 4 was unfertilized both seasons, and in 1929 Plot 6 received only phosphoric acid and potash. Plots 7, 8, and 9 were cut for hay in early June and then used for reserve pasture during the latter part of the season. In the early spring Nitrophoska II, a high analysis complete fertilizer, was applied. Calurea, a concentrated nitrogenous fertilizer was applied as a summer top-dressing three times during the season. The cattle were divided into groups—high producers, low producers, and dry cows and young stock—and were rotated from plot to plot, the first use of the fresh pastures always being available to the high producers who were followed in turn by the other two groups.

Accurate records were kept of the condition of the cattle, milk produced, additional feed consumed, and cost of all field operations. A daily record was kept for every plot of the number of each class of stock and the amount of milk produced. The day before the cows were turned onto a plot, grass samples were taken and analyzed for protein content by the Department of Chemistry. These were found to average 17.5 per cent crude protein in dry matter on the fertilized plots, as compared with 12.2 per cent on the plot which received no nitrogen.

Both pasture seasons have been abnormal; the first extremely wet and the second very dry. From the results obtained it is expected that a normal season will show much greater possibilities for the system; therefore, it is planned to continue the experiment.

The results so far seem to warrant the following conclusions:

1. A heavy, thick turf is essential for the best results from fertilizer application.
2. The application of fertilizer increases the quality and quantity of pasture grass.
3. Nitrogenous fertilizers are necessary for the greatest return, when a good pasture turf is established.
4. Proper management of the herd and plots, combined with fertilizer treatment, is essential for the greatest net returns from an intensive grassland system.

DEPARTMENT OF FARM MANAGEMENT

J. A. Foord in Charge

Enterprise Relationships and Farm Organizations on Selected Dairy Farms in Western Massachusetts. (R. L. Mighell). This project, begun in the latter part of 1928, has been continued throughout the year and quite complete records of the year's work on 19 selected dairy farms in the western part of the state have been obtained. Records of labor and its distribution, as well as of the financial and material income and outgo, have been secured and should yield valuable data when tabulations and comparisons are made.

The Place of Poultry Production on Massachusetts Farms. (R. L. Mighell and F. H. Branch). Work on this project was completed and the results published as Bulletin No. 251. (See list of publications).

Types of Farming in Massachusetts 1840-1925. (Marian Brown). This project was planned as a historical study to form a basis for future work. Most of the material and data had been collected at the time of Miss Brown's resignation in October, and will be prepared for publication by another member of the department.

Factors Responsible for Variations in Production and Cost of Milk in Massachusetts. (R. L. Mighell). Some progress has been made in reviewing the literature and accumulating data on this project, but more work must be done before definite conclusions can be reached.

Other Activities. The Department has cooperated with the State Department of Agriculture and the Massachusetts Industrial Commission in a business survey of Connecticut Valley farms, the planning and supervision of the field work being entirely cared for by this department. Records of approximately 350 farms, mostly those producing onions and tobacco, have been secured, and a careful tabulation and study are being made of the data.

FEED CONTROL SERVICE

Philip H. Smith in Charge

The Feed Control Service comprises not only feed inspection, but several other activities, as listed below:

Feed Control (General Laws, 1920, Chapter 94)

Seed Control (General Laws, 1927, Chapter 94)

Dairy Law (General Laws, 1920, Chapter 94)

Advanced Registry Testing

Miscellaneous Work

Feed Control. (P. H. Smith, H. R. DeRose, J. W. Kuzmeski, M. W. Goodwin¹, J. B. Zielinski, Jr., F. A. MacLaughlin). During the fiscal year, 1640 samples of feeding stuffs officially collected were examined in the control laboratories. The results indicate that guarantees placed upon these products are with few exceptions reliable, and that such lapses as occur are not serious. The retail feed business is gradually being absorbed by chain systems, which may in time seriously affect the revenue accruing to the State through the reduction of the number of brands of feeding stuffs sold. During the past year the gross receipts from this source were \$19,800 derived from 990 registrations at \$20 a brand. Of this sum, \$11,000 is appropriated to the Experiment Station for the purpose of feed control.

Seed Control. (P. H. Smith, O. W. Kelly, C. L. Beane²). The seed laboratory has been established at the Experiment Station primarily for the purpose of inspecting seed samples collected by the State Commissioner of Agriculture, who is designated under the act as administrative officer.

¹Resigned October 1, 1929.

²Resigned November 1, 1929, to accept the position of chief clerk in the Department of Botany.

The work accomplished during the two years that the law has been in operation indicates that, on account of the general good quality of seed offered, the laboratory can consistently devote less time to seed inspection and rather more time to research problems pertaining to seed.

Summary of Samples Analyzed, 1929

	Non-Official	Official	Total
Purity analysis only	27	55	82
Germination test only	228	181	409
Both purity and germination test required	131	249	380
Totals	386	485	871

In cooperation with the Department of Vegetable Gardening, 93 samples of onion seed were examined; and 31 samples of alfalfa and clover seed were submitted to the Department of Agronomy for field tests in order to determine trueness to type.

Dairy Law. (P. H. Smith, J. T. Howard, H. L. Allen). The work under this law involves:

1. The testing of Babcock glassware for accuracy.
2. The examination and award of certificates of proficiency in the use of the Babcock test.
3. The annual inspection of creameries, milk depots, and board of health laboratories where the test is used as a basis for fixing the value of milk and cream.
4. An amendment to the Dairy Law enacted at the 1929 session of the General Court authorizes the adoption of Rules and Regulations in order to promote uniformity and accuracy in testing. These rules and regulations have been published and distributed to operators. This amendment also makes possible investigation in order to determine if these rules and regulations are followed.

During the year ending December 1, 1929, 8515 pieces of Babcock glassware were tested. Condemned bottles amounted to less than one per cent of the total tested. Eighty-nine certificates of proficiency were awarded. One hundred and fifty-three creameries, milk depots and milk inspectors' laboratories were visited in order to check methods and pass upon equipment in use. As a result of this inspection, major repairs were ordered on 12 machines, minor repairs on 30, and 2 machines were condemned outright. Sealed glassware was ordered at four places, and cream scales at the same number.

Advanced Registry Testing. (P. H. Smith). At the present time the work of Advanced Registry Testing is cared for by the services of one clerk and seven supervisors. The volume of work does not change materially from year to year. In November, 1929, there were on test 568 cows, located on 78 different farms. Many of the pure bred cattle clubs are now giving recognition to Herd Tests in addition to the testing as it has been practiced in the past where individual animals of expected high production were selected for record work. The Herd Test is an incentive to breeders to maintain a high average production in their herds, with the consequent weeding out of inferior animals.

Miscellaneous work. (P. H. Smith, H. R. DeRose, J. W. Kuzmeski, J. B.

Zielinski, Jr.). Numerous analyses are made for residents of the State and other departments of the College. Analyses requested must be comparable to the general routine work of this department.

Summary of Miscellaneous Work, 1929

Materials sent in:

Milk and cream, butter fat only	502
Milk, solids and fat	75
Feeds	97
Pasture grass, dry matter	562
Pasture grass, fodder analyses	45
Pasture grass, nitrogen	47

For other departments of Experiment Station and College:

Milk for butter fat	127
Moisture tests, forage crops	706
Complete fodder analyses	192
Moisture tests and nitrogen	158
Chicken bones	2

FERTILIZER CONTROL SERVICE

H. D. Haskins in Charge

Fertilizer Inspection. (H. D. Haskins, H. R. DeRose, M. W. Goodwin, J. W. Kuzmeski, J. B. Zielinski, Jr.). During the season of 1929, 104 firms or individuals have registered in Massachusetts 638 brands of fertilizer, unmixed fertilizing materials and agricultural lime. The following table shows the nature of these materials as well as statistics with reference to their inspection.

Products	Brands Registered	Brands Collected	Samples Collected	Number of Analyses	Number of Determinations
Mixed fertilizers	365	347	1131	536	7341
Ground bone, tankage and fish	66	61	144	81	419
Nitrogen products, organic and mineral	78	69	229	143	440
Phosphoric acid products	33	30	102	42	231
Potash products	32	30	68	38	115
Dried pulverized natural manures	17	16	69	16	110
Miscellaneous materials	16	15	29	22	163
Lime products	31	30	62	35	267
Totals	638	598	1834	913	9086

In securing representative samples for the year's inspection, the four agents sampled 22,257 sacks or containers, representing 8285 tons of material; about 266 towns and 1005 agents were visited.

From July 1, 1928 to July 1, 1929 the following tonnages of fertilizer and plant food were sold in Massachusetts:

Fertilizer and Plant Food Tonnage

	Fertilizer	Plant Food Elements Available		
		Nitrogen	Phosphoric Acid	Potash
	Tons	Tons	Tons	Tons
Mixed fertilizers	41,529	1730	3206	2549
Unmixed fertilizer chemicals and materials	18,788	1115	1737	596
Pulverized natural manures	2,174	51	32	68
Totals	62,491	2896	4975	3213

Full details of the fertilizer and lime inspection work may be found in Bulletins 51 and 52, Control Series.

Miscellaneous Analytical Work. (H. D. Haskins, H. R. DeRose, M. W. Goodwin, J. W. Kuzmeski). Between November 1, 1928 and April 1, 1929, the activities of the department included cooperative chemical work with other departments of the institution. The general nature and extent of this work is shown by the following summary:

Soil, complete mineral analysis	20
Corn plants, complete ash analysis	9
Alfalfa, partial ash analysis	6
Timothy, partial ash analysis	4
Tobacco leaf, complete ash analysis	4
Tobacco leaf, dry matter and partial ash analysis	59
Tobacco stalks, dry matter and partial ash analysis	67
Soil, for carbon, nitrogen, carbonic acid, organic and volatile matter	26
Processed organic ammoniates, complete analysis including nitrogen activity tests	24
Manure, complete fertilizer analysis	4
Insecticides	2
Millet seed and straw, dry matter and nitrogen	96
Gladiolus bulbs, ash analysis	1
Ground seeds of plants, ash analysis	4

The department has also made the following analyses for farm organizations, institutional departments, and private individuals. For this latter service a nominal charge is made.

Fertilizers	21
Peat and pond deposits	22
Lime products	5
Pulverized manures	4
Cotton waste products	4
Mulch	3
Soils for partial analysis	23
Wool waste	2
Boiler sludge	2

In addition to the above, the department has cooperated as usual with the Association of Official Agricultural Chemists.

Vegetation Pot Experiments. (H. D. Haskins, A. B. Beaumont, G. J. Larsinos). This experiment, comprising 96 pots, was conducted in further

study of the nitrogen availability of processed low grade organic substances high in nitrogen which are used in mixed commercial fertilizers. Also, pots were included to note the effect of the use of varying amounts of manganese sulfate. Results of both experiments are reported in Control Bulletin 51.

DEPARTMENT OF HOME ECONOMICS RESEARCH

Esther Davies in Charge

Present Practices of Massachusetts Elementary Schools with Regard to School Feeding and Transportation and Their Effects upon Health of Pupils. (E. Davies and C. B. Church.). The field work for this project has been completed, most of the data tabulated, and a report of the findings with regard to food service has been prepared. The 222 towns of less than 5,000 population included in the study have a total elementary school enrollment of 57,600 pupils, 15,000 of whom must be furnished transportation to and from school. These towns have 800 school buildings: 370 one-room, 208 with two or three rooms, and 222 with four or more rooms. In 71 per cent of the buildings there is no food service of any sort at any time in the entire school year, and only one-fourth of the others have anything more than a haphazard service during the winter months. In general, the decision with regard to food service rests entirely with the individual teacher, and there is neither encouragement nor appreciation of her efforts on the part of the school administration.

Detailed records as to the cause and the duration of absences from school were kept by the teachers of 16 schools scattered throughout the State. The average number of days attended is greater for the children who walk to school than for those transported. The incidence of absence due to illness is the same for the two groups, but the illness absences of the transported group are of longer duration. The greatest difference between the two groups is in the amount of time absent from school in order to work at home. The transported group, either because of distance from the truant officer or because there are more tasks which can be delegated to the farm child, has three times as high a percentage of absence due to labor at home as has the group who walk to school.

The report gives an analysis of the situation now existing with regard to school feeding and transportation, and recommendations of improvements which might be made without appreciable added financial burden on the rural towns.

The Comparative Values of Milk and Tomato as Supplementary Feeding in a Rural Elementary School. (E. Davies and C. B. Church). This project was undertaken to determine to what extent the nutritional status of the elementary school child can be improved by school feeding, and whether—given the usual home diet of rural Massachusetts—milk or a vitamin C rich food is the better for the purpose. Work was begun in September, 1929, in the schools of a typical rural town, and the experimental feeding is to be continued for two school years. No conclusions can be reached before the end of the experimental period.

DEPARTMENT OF HORTICULTURAL MANUFACTURES

W. W. Chenoweth in Charge

The Extraction of Fruit Juices by Heat. (C. R. Fellers). This project has been continued, using small fruits including raspberries, blackberries (wild and cultivated), blueberries, currants, plums and grapes. With the experimental data complete, the results of the two-year study on small fruits will soon be presented as a bulletin.

The use of pectin in fruit jellies has been studied, and work has been done on a method for home extraction of pectin from cull apples or thin-rings. In cooperation with the Department of Dairy Industry, the substitution of pectin for gelatin as an ice cream stabilizer was found to decrease overrun.

The use of frozen apples for cider making was found to be satisfactory, the expressed juice being very heavy and rich in pectin. This juice with added sugar gives an excellent cider jelly.

Manufacture and Preservation of Cranberry Products. (C. R. Fellers and F. P. Griffiths, W. W. Chenoweth). Several barrels of cranberries were canned in various types of tin cans and glass jars and some stored for a year at 90° F., 70° and 45°. The effect of cold storage upon the quality of canned cranberry sauce was very marked, the discoloration and abnormal flavor being very much reduced. A good cranberry sauce was found to jell at 216-218° F., contained approximately 43 per cent sugar, and showed a bloom jelly strength of about 150 grams. Close cooperation with the several cranberry packers and the State Cranberry Station at East Wareham has been maintained in this project.

The development of a cranberry syrup was attempted. It was found impossible to eliminate a very troublesome pectinous precipitate from the syrup. The condition was remedied somewhat by using a very short extraction period and expressing the juice before all of the pectin had been liberated.

Candied cranberries were made in the laboratory and seem to be in many ways superior to the commonly used candied cherries.

Utilization of Onions by Canning. (C. R. Fellers). Further progress has been made, particularly in methods of preparation of onions for canning. A short blanching (1.5—3 min.) in boiling water loosens the outside skin and greatly facilitates its removal. The use of zinc enamelled tin cans to prevent a black or smut formation has again proved very efficacious. The onion contains much loosely combined sulfur which is liberated during the canning process and combines with metals of the container to form sulfides. Since zinc sulfide is white, there is little objection to it.

Work on onion pickling and drying has been continued. Several pounds of onion powder for flavoring foods was prepared. It is believed this product has good commercial possibilities.

The Nitrogen Distribution of the Edible Portion of the Onion. (F. P. Griffiths). The total nitrogen and various amino acid fractions were estimated. The Van Slyke separation method was used.

Utilization of frozen fruits in ice cream. This joint project carried on in the departments of Dairy Industry and Horticultural Manufactures is

now in its second year. Two fruit crops consisting of strawberries, raspberries, blackberries, cherries, and peaches have been cold packed with various ratios of cane and corn sugars, stored at 15°F., and used in fruit ice cream mixes. The most satisfactory varieties of strawberries were Howard 25, Howard 17, Bliss, King Edward, Beacon, First Quality and Marshall, while Herbert, Cuthbert and St. Regis varieties of raspberries were very suitable for cold packing. The optimum fruit to sugar ratio was 2 to 1 and 3 to 1 for strawberries and cherries and 3 to 1 for raspberries and peaches. Corn sugar discolored the fruit and was unsatisfactory. Fruits frozen without sugar lost, to a considerable degree, their characteristic fresh flavor and color. Prompt freezing at 0°F. followed by cold storage at 15°F. or less kept the fruit in good condition for over a year. Such frozen fruit was comparable to fresh fruit for use in ice cream, jams, jellies, and juices.

Pasteurization of Dried Fruit. (C. R. Fellers and J. A. Clague). Research has been conducted on the heat treatment of dried fruits, particularly dates and figs, with the view of developing an effective pasteurizing procedure for these products. A preliminary report on this work is now in press (*American Journal of Public Health*). A heat treatment of 180° F. for 60 minutes at 75 per cent humidity will effectively destroy *Escherichia coli* in packaged dates and actually improves the quality, texture, and color of the fruit.

Non-Project Research. (C. R. Fellers). The canning of citrus juices, the fermentation and preservation of citron, and a preliminary study of cider preservation with benzoates have been carried on.

DEPARTMENT OF LANDSCAPE GARDENING

Frank A. Waugh in Charge

Lawns and Lawn Grasses and Lawn Management. (L. S. Dickinson).

As the summer of 1929 was unusually dry, important observations have been made concerning the advisability of fertilizing turf during a hot dry season. Excellent turf of each of the basic grasses—bent, Kentucky blue grass, and fescue—has been maintained by monthly applications of castor bean pomace or cottonseed meal. Check plots receiving no fertilizer were severely dried, thus permitting an invasion of weed growth.

Additional field studies have been made of the fungus causing spow mould, and laboratory experiments have been conducted during the summer concerning the large brown patch disease (*Rhizoctonia solani*). These experiments verified the field observations, and it now appears that an attack of this disease can be accurately forecast.

Seven species of grasses imported from Germany are being tried as fairway grasses, and there have been many strains of bent added to the trial plots. Also, several strains of bent have been discarded, as they did not appear to be adapted to putting conditions.

The series of plots established in the fall of 1928 in cooperation with the United States Golf Association wintered very well, and while only one year old they are furnishing many data. In this series the annual blue grass and European red fescue plots were much affected by the hot dry season.

Approximately one acre more land has been assigned to turf culture studies. This will be used for variety plots, turf nursery, and student plots.

DEPARTMENT OF PLANT AND ANIMAL CHEMISTRY

J. B. Lindsey in Charge

The Efficiency of Copper Fungicides. (E. B. Holland and others). A summary of the laboratory work relative to the preparation of low and high basic copper sulfates and of the composition and physical characteristics of the laboratory and manufacturers' samples has been presented in Bulletin 254 together with the results of several year's field tests of their efficiency as fungicides, both as sprays and dusts, in the control of diseases on cucumbers, celery, potatoes and fruits. The project is held in abeyance awaiting further developments of the subject.

Supplements for Copper Fungicides. (E. B. Holland and others). Data from many experiments made at this Station, both in the laboratory and in the field, pertaining to the use of supplements for incorporation into different copper fungicides intended to remedy some real or fancied defect have been published in Bulletin 252, to which the reader is referred for full information.

The Effect of Fertilizer and Cultural Treatment on the Nitrogenous Compounds of Havana Seed Leaf. (P. R. Nelson). The work on tobacco originally undertaken by E. B. Holland and continued by P. R. Nelson endeavored to measure the effect of varying amounts of nitrogen, high and low topping, and different stages of maturity on the nitrogen compounds of "seconds" grown on the experiment plots during the season of 1928. This is a sub-project of the Department of Agronomy and is further reported by that department.

Oil Sprays. (E. B. Holland). A study of oil sprays has been undertaken with the view of determining the relative composition of the different brands of stock emulsion and miscibles that have been employed by the Department of Entomology. An effort is being made to produce similar products of definite composition for field tests. Definite results are not yet available for publication.

Nitrogen Fixation in the Presence of or as a Result of the Growth of Legumes versus Non-Legumes Under Certain Defined Agronomic Conditions. (F. W. Morse). The crops produced this year (1929) were red clover for a legume and timothy for a non-legume. They were the second year's product from the seeding in the spring of 1928 described in last year's report. Both lots wintered well. Conditions were favorable for growth until early in June, after which there was little rainfall. The crops were cut, sampled and weighed on July 1 and 2. They were a repetition of those produced in 1924, therefore a comparison of results for the two seasons is of interest. The comparison is made between the products of the areas that have not received nitrogen in fertilizers since 1882.

Dry Matter and Nitrogen Removed from the Plots
(Kilograms per Acre)

	Dry matter		Nitrogen	
	1924	1929	1924	1929
Clover, Plot 7	1552	1712	43.2	41.2
Clover, Plot 9	1868	1838	49.9	41.9
Grass Plot 7	408	508	3.4	4.9
Grass Plot 9	496	623	4.5	6.1

The particularly interesting result is that after an interval of five years of continuous cropping and removal of nitrogen, the soil which has not grown a leguminous crop in that period held its own and something more, measured by both dry matter and nitrogen in the crops removed this year.

Chemical Changes in the Cranberry During Ripening and After Harvesting. (F. W. Morse). The work during the past year has been principally the analysis of numerous varieties of cranberries and samples from different bogs. Numerous specimens of the 1929 crop have been received from New Jersey and Wisconsin cranberry growers, as well as from the Cape Cod region. At this time it is possible to report nothing more than the range of percentages found by the determination of total acid, total sugar and dry matter in the varieties so far examined.

Ten varieties of the crop of 1928 were received from Cape Cod growers in November of that year. During October and November of this year, there have been analyzed 41 varieties of the crop of 1929 which were representative of all three states—Massachusetts, New Jersey and Wisconsin. The results expressed as minima and maxima so far observed are as follows:

		Dry Matter	Total Sugar	Total Acid
		%	%	%
1928	10 varieties	11.3-13.1	3.45-5.22	2.14-2.79
1929	41 varieties	11.2-13.5	2.50-5.45	2.07-2.71

The much wider range in percentages of sugar in 1929 was probably due to a wide variation in the maturity of the fruit when harvested. The study of cranberries during ripening has shown that sugar is rapidly increased during the last week on the vines, accompanied by a noticeable development of color of the berries. Several samples of this year's crop were very light colored, and the lowest percentages of sugar were found among them.

Record of the Station Herd. (J. B. Lindsey and J. G. Archibald). This project has been carried on over a long period of years incidental to other work. The records for 1928 show that twelve cows (ten grade Holsteins, one grade Jersey, and one pure bred Jersey) completed a normal lactation period during the year. The average production was 9045 pounds of milk testing 12.27 per cent solids and 3.8 per cent fat, with a feed cost per cow of \$164.97, or 4.01 cents per quart of milk. Feed cost was based on hay at \$20, silage at \$8, green feed at \$8 a ton, and grain at market price. Under conditions prevailing it was not practicable to determine the overhead.

In 1929 the herd included 20 cows milked during the year. A number, however, had only short lactation periods, varying from a few days to six months. The records of ten cows having normal lactation periods are as follows: Average yearly production 8534 pounds, testing 12.40 per cent total solids and 3.97 per cent fat, with a feed cost of \$143.63 per cow, and 3.70 cents per quart of milk. The feed cost of roughage was figured on the same basis as for 1928, with grain at prevailing market prices. The feed cost of milk was a little less in 1929 than in 1928 due, in a measure, to the increased use of roughage and less grain.

Milk Substitutes in the Growing of Young Calves. (J. B. Lindsey and J. G. Archibald). Results of work on this project over a period of several years have recently been published in Bulletin No. 253. The method which has been the most satisfactory compromise between economy and good growth has involved the use of skim milk powder in limited amount (about 125 pounds per calf) up to four months of age.

The project is being continued with the idea in mind of developing a system based largely on dry feeding after the first few weeks, little or no liquid except water being fed.

Mineral Supplements for Dairy Cattle. (J. B. Lindsey and J. G. Archibald). The final report of six years' investigation of this subject has recently been published in Bulletin No. 255. Little, if any, benefit was noted from the feeding of bone meal. Some slight benefit was noted from feeding dicalcium phosphate (precipitated bone), but not sufficient to warrant recommendation of its general use. Average producing cows (5000-8000 lbs. yearly) fed on good quality roughage with the amounts of grain ordinarily fed in New England seem to obtain sufficient mineral matter from their ordinary feed. Heavy producers may benefit from the addition of mineral supplements, but the efficacy of the practice is by no means well established.

Mineral Constituents of Forage Crops. (J. B. Lindsey and J. G. Archibald). Results of this project form a part of the above-mentioned Bulletin No. 255. No pronounced deficit of mineral constituents has been noted in the Massachusetts roughages examined in the course of this work. The calcium content of the hays analyzed is worthy of note, it being somewhat higher than the values given by other authorities.

Mineral Requirements for the Growth of Dairy Heifers. (J. B. Lindsey and J. G. Archibald). Work on this project, organized about three years ago, is being actively pursued. At date of writing (December, 1929) eight heifers have been carried through two years of intensive experimental trials, four on a ration high in calcium, and four on a ration low in that element. An accurate check has been kept on the intake and excretion of calcium and phosphorus by these animals, and careful growth records have been kept. The work has not yet reached a stage where definite conclusions are warranted. Of necessity it must be a long-time project.

A Comparison of Two Systems of Dairy Cattle Feeding—High Roughage and Low Grain vs. Low Roughage and High Grain. (J. B. Lindsey and J. G. Archibald). This project was organized a year ago in order to obtain some definite experimental evidence on a problem which is much discussed by practical feeders and on which various recommendations

have been made from time to time, but without a definitely established basis of fact.

The Station herd has been divided into two groups, one receiving grain at the rate of one pound to four and one-half pounds of milk, 40 pounds of silage and what hay they will clean up; the other group receiving grain at the rate of one pound to two and one-half pounds of milk, 25 pounds of silage and what hay they will clean up. The cows are being carefully observed, and the usual checks on live weight each month, milk production, and the reproductive function, are being maintained. It is too soon to draw definite conclusions from the trial. The plan is to continue it for at least three lactation periods of all the cows.

The Chemical Composition of Grass from Plots Fertilized and Grazed Intensively. (J. G. Archibald). The department has cooperated during the past two years in a study of an intensive system of grassland management being carried out on the College farm. A study has been made of the chemical composition of grass as affected by the intensive fertilizer treatment and grazing which the system involves. Results for 1928 have been published in the *Journal of the American Society of Agronomy* for June 1929. The study for 1929 has not yet been completed. Briefly: the fertilizer treatment increased the percentage of nitrogen, phosphorus, and ether extract, and decreased slightly the percentage of crude fibre and calcium, in the dry matter of the grass. Acre production of all constituents was increased, nitrogen being nearly doubled, while phosphorus and ether extract were increased by about one-half.

A study of the seasonal variations in composition showed that grass kept in the vegetative stage by grazing may be quite different in chemical composition in midsummer from what it was in the spring. The seasonal factors, rainfall, temperature and sunshine, exert their influence irrespective of the stage of growth of the plant.

Utilization of Onions by Canning. (C. P. Jones). The object of the studies on the chemistry of the onion has been to ascertain (1) its mineral and proximate food constituents, (2) the cause of its discoloring action upon the tin in which it is processed, and (3) the reason for the darkening of the onion itself in the canning process. Many of the inorganic and organic constituents of the onion have been already determined. Further additions relative to both are to be made.

Discoloration of Can. Preliminary studies made on the discoloration of plain tin cans by commercially processed fruits, vegetables, flesh products and soups, and by laboratory canned materials indicated that sulfur from the protein molecule caused the discoloration. Experiments conducted with cysteine hydrochloride further confirmed this view. In the case of the onion, other sulfur compounds are present in addition to those associated with the protein molecule, and were therefore considered as possible discoloring factors.

Unfortunately, lack of laboratory facilities prevented the extraction, recovery and consequent identification of the sulfur oils contained in the onion. However, several analogous oils (technical alkyl sulfide and disulfide, allyl sulfide, and mustard oil) were investigated as to the probability of such sulfur compounds constituting discoloring agents. This was found not to be the case, with the exception of mustard oil. The presence of

mustard oil would result, through decomposition, in the discoloration of the can to some degree.

Tests indicated that the metallic film formed on the sides of the can was a sulfide of tin rather than of iron.

Black deposits occurring on the head space end of some enameled cans were removed and tested for their metallic constituents. Both iron and zinc were found present. Zinc oxide is a constituent of the enamel coating. The amount of iron obtained indicated other forms besides the sulfide, presumably oxides.

Discoloration of the Onion. In all cases canned onions were found to be normal both in firmness and color when removed from the can, while the onion liquor was of a pale green color. Exposure to the air or to the influence of oxidizing agents resulted in the development of a dark olive green color of tissue and to a dark green to brown coloration of the liquor, regardless of whether the product was processed in plain tin or enameled cans. Onions processed in glass, on the other hand, when exposed to the same oxidizing conditions, discolored slowly, changing in color to a light brown only upon long standing. This pronounced difference in color between onions processed in glass and those canned in tin was believed to be due to the influence of soluble iron.

Examination of the liquor from both the plain and enameled cans proved the presence of considerable ferrous iron in solution. Much more iron was recovered from the liquor of the plain can than from the enameled can.

A flavonol pigment, probably quercetin, was proved to be present in the onion bulb. It was found distributed throughout the fleshy inner tissues as well as in the dried outer scales. Experiments carried out with commercial quercetin showed that ferrous ions failed to produce any colored compound, whereas ferric ions resulted in the formation of an olive green to reddish brown ferric compound and also reddish brown solutions depending upon the proportion of iron to pigment.

These investigations indicate that the discolored film produced upon the sides of the plain can in the processing of the onion is due to the formation of sulfide of tin, the source of the sulfur being the sulfur compounds of specific proteins; while the black deposit occurring on the head space end of some enameled cans was largely iron, part as a sulfide and part as oxide. The discoloration of the onion itself is due probably to the presence of iron and quercetin or a similar pigment in solution. The development of the discoloration is believed to involve the following steps: First, metallic iron from the can is rendered soluble by the action of oxygen contained within the head space of the can and also by the solvent influence of the acids and salts of the onion; secondly, the ferrous iron thus formed reacts with the pigment forming the ferrous compound of the pigment; and finally, this ferrous iron, when exposed to the atmosphere, oxidizes and forms an olive green ferric derivative of flavonol.

DEPARTMENT OF POMOLOGY

F. C. Sears in Charge

The Interrelation of Stock and Scion in Apples. (J. K. Shaw and J. S. Bailey). The usual records of growth, bloom, and yield of the trees in the eleven-acre orchard have been taken during the year. The trees have responded to increased applications of nitrate of soda with better growth, and the 1930 crop should be somewhat greater than the rather small crops of previous years. The grass has been suppressed over a space about five feet in diameter around the tree trunks in an effort to prevent girdling by mice. No such injury has appeared since this practice has been followed. Inasmuch as the lease of this land expires in two years, it is probable that the report on this project will be held until the expiration of the lease. No new tendencies have appeared in the past year.

The orchard set in 1928 consisting of McIntosh and Wealthy trees on Clonal stocks from the East Malling, England, Experiment Station, have made a good growth, it being necessary to replace only two trees. It will, of course, be several years before any report can be made of the comparative value of these stocks for the two varieties used. It seems as though there may be possibilities for commercial orchards on these stocks which may be expected to produce semi-dwarf trees which will come in bearing early, thus reducing the capital investment in an orchard at the start of production.

Root cuttings from several of these stocks were set in the spring of 1928 and were large enough to bud the second season. In order to make this method of propagation practical, it must be shown that they have considerably greater value than seedling stocks. Probably the more usual method of mound layering is preferable. It is planned to dig the several hundred of these stocks now in the nursery rows in the spring of 1930, increasing them so far as possible and establishing a new nursery for layering these stocks.

Tree Character of Fruit Varieties. (J. K. Shaw and A. P. French). A study of varietal characteristics of nursery trees continued the past summer, largely in connection with the work of the leaders of this project in certifying varieties for the Massachusetts Fruit Growers' Association. More than two million trees were examined. Substantial progress has been made in determining characteristics for the identification of sweet cherry varieties, and it is now thought possible to detect mixtures of cherry varieties with a fair degree of certainty. This should be valuable, as cherry varieties have been badly mixed in the nursery. Little work has been done with pear and plum varieties for there is at present little demand for these fruits. There are few serious difficulties in variety identification. The problem of peach variety continues troublesome, and yet there is enough known to detect many mixtures and misnamed trees.

A variety nursery was established in the spring of 1929, and grafts and buds of more than one hundred varieties of apples are included. These include all the varieties of apples that are extensively grown in American nurseries, also many new varieties that may have a place in the near future. A few varieties of peaches were also included. It is planned to make a critical study of these varieties as one-year trees in 1930 and as

two-year trees in 1931. The photographic method will be used, and it is felt that real progress can be made in recording various differences so they may be understood by anyone familiar with nursery trees.

The Genetic Composition of Peaches. (J. S. Bailey). The orchard of about 1200 selfed and cross-fertilized seedlings planted in the spring of 1928 made satisfactory growth during the past season, and only a very few trees died. Few studies were made the past season, but with the trees in good growth it is expected that studies will be made the coming summer. Some additional work in crossing varieties was done the past summer, but for some unknown reason very few fruits were secured.

The freezing apparatus designed for use in the study of fruit bud hardness in connection with this project has been completed and considerable data have already been accumulated bearing on the killing point of buds of different varieties and on the effect of various conditions on the killing point. This work is slow and painstaking, and considerable time will be required before sufficient data can be accumulated to warrant definite conclusions.

Testing Methods of Pruning. (J. K. Shaw). This project has been continued the past year, but no attempt to summarize the results has yet been made. No obvious differences have appeared in the quality and quantity of the fruit borne on the heavy pruned, light pruned, and unpruned trees.

Effect of Pruning on Bearing Apple Trees. (F. C. Sears and J. K. Shaw). The past season was the third year of this experiment on old bearing trees. There seems to be a slight though not very consistent increase in size of fruit on the heavy pruned trees. The fruit from these trees is graded according to the State Grading Law each year, and notes of size, color development, and various insects and diseases have been made. No striking differences have appeared; yet the data must be carefully examined before safe conclusions can be drawn.

Comparison of Cultivation and Sod in a Bearing Orchard. (J. K. Shaw). The experimental program as modified in 1927 has been continued. Where nitrate of soda has been used on trees in cultivation without fertilizer, there was distinct increase in yield. Whether a midsummer application of nitrate of soda has increased yield is yet uncertain. The same may be said relative to the sod plot which has for the past three years received potash in addition to nitrogen.

The fertilizer test in the orchard formerly devoted to the study of head formation has continued as for the past four years. No careful study of data has been made, but it seems clear that the nitrogen has improved the trees, although perhaps the unfertilized plots show better performance than one would expect from trees on rather poor soil which has been without fertilizers since the planting of the trees in 1916.

Comparison of Clover Sod and Grass in Sod Mulch Orchard. (J. K. Shaw). This project is a comparison of a complete fertilizer with phosphorus, potash and lime designed to bring in a sod of white clover which may be expected to furnish nitrogen for the trees. The white clover appeared first in 1927 and has been slowly spreading, as the fertilizer treatment has been continued. The trees with complete fertilizer con-

tinue to yield more heavily, but it will be interesting to see what happens if the white clover spreads over the entire area of the plot.

Test of Different Amounts of Nitrate of Soda. (J. K. Shaw.). This test on thirty-year-old Baldwins in sod has continued as in the past. No injury to the trees has yet resulted from the use of twenty-five pounds of nitrate of soda per tree. Owing to the small number of trees involved in this experiment, a considerable number of years will be required before it is safe to draw any conclusions.

Comparison of Cultivation and Heavy Mulching for Apples and Pears. (J. K. Shaw). This experiment has been continued as in previous years. The mulched trees continue to yield heavier crops and no injurious effects of the large amount of nitrates in the soil under the mulch have been observed. There seems to be a heavier drop from the trees on the mulch plot just before harvesting, but this is not very serious as the apples are little damaged and may be sold for good prices. It is felt that the system of mulching trees with enough hay or straw to suppress the growth of grass around the trees has possibilities in Massachusetts orcharding.

The Effects of Fertilizer Limitation on Fruit Plants. (J. K. Shaw). This project has been continued as in previous years and nothing new has appeared during the past season. Owing to the fact that the trees, now seven years old, must have sent their roots beyond the boundaries of the plots which are only ten feet wide, it is planned to remove these trees and reset the area with other trees on uniform roots. While the differences between plots have been marked, there are also very great differences between individual trees on the same plot.

Role of Potash and Lime in Fruit Tree Nutrition. (J. K. Shaw). The study of the soils on the orchards referred to in the previous paragraph by means of experiments carried out in Wagner pots, has been continued. Soil from the field plots was placed in the pots after various fertilizer chemicals had been mixed in the soil. The general question of whether the beneficial effects of potash and lime observed in the field were genuine has again been answered in the affirmative, although not quite as emphatically as last year.

Addition of nitrate of soda to soil from the potash plots failed to increase growth as much as lime; therefore, it seems that the increase of soil nitrates in plots receiving lime cannot be the sole cause of improved growth. It is planned to continue this study next year.

Effect of Potash and Lime on Apple Trees. (J. K. Shaw). This project is carried out in an orchard planted in 1915 and involves comparisons of nitrate of soda, potash, superphosphate, and lime, alone and in various combinations. Certain plots are fertilized so as to establish a sod of white clover. This has been successful in many cases and seems to have been beneficial to the trees. Still the trees receiving nitrogen have yielded better than those without, although the difference is not great. No superiority of color of apples from plots receiving complete fertilizer over those from plots receiving nitrogen alone has been observed. In general there is a tendency for plots receiving nitrogen to be inferior in color to those receiving no nitrogen from fertilizers. Observation in this orchard

must be continued for several years longer before final conclusions can be drawn.

Study of Varieties of Tree Fruits. (J. K. Shaw and O. C. Roberts). The observations on many varieties of tree fruits growing in the College orchards, which have been carried on for several years, were continued this year. With the accumulation of a considerable number of years' records, it should be possible to make some deductions as to the relation of climatic conditions to bloom and yield.

Fruit Bud Formation in the Strawberry. (R. A. Van Meter). This project was started in the spring of 1928 to study the effect of soil nitrates on fruit bud formation and on fruit production. Forty-five plots of thirty plants each were established in 1928, involving nine fertilizer treatments replicated five times, as given in the last annual report. No differences were observed in the appearance of plants on the different plots either during the summer of 1928 or in the spring of 1929 prior to fruiting. The summer of 1928 was moist and all plots grew well.

At harvest time the fruit from each plant was checked and graded for size. Differences between treatments were slight, but there seemed to be a consistent difference in favor of the later applications.

A new series of forty-five plots of sixty plants each was established in the spring of 1929. These are in nine series, treated as follows:

1. No nitrates
2. August 5, nitrate of soda
3. August 16, nitrate of soda
4. August 16, sulfate of ammonia
5. September 3, nitrate of soda
6. September 16, nitrate of soda
7. September 16, sulfate of ammonia
8. October 4, nitrate of soda
9. October 22, nitrate of soda

Nitrate of soda was applied at the rate of 309 pounds per acre, and sulfate of ammonia at the rate of 232 pounds per acre. Superphosphate at the rate of 600 pounds per acre and muriate of potash at 150 pounds per acre were worked into the soil along the rows immediately after planting. All plants made an excellent growth, and no differences between plots were observed during the summer.

Work not on a Project Basis. As in previous years, work has been done along lines not definitely classified under the various listed projects. This is mostly by members of the Pomology Department not on the Station Staff. The principal work along these lines is briefly mentioned.

The "Set" of McIntosh Apples in Middlesex and Worcester Counties. In the spring of 1929 county extension services and certain growers in these two counties reported that McIntosh apples failed to set properly and asked for assistance from the Experiment Station. Prof. Bailey and Mr. Roberts spent some time in these two counties cooperating with the county agents in studying this situation. Considerable data were collected and these indicated that the set was not as poor as had been reported. This observation seems to be supported by the fact that the crop at harvest was at least fair. The McIntosh is one of the varieties that blooms rather freely every year, but suffers a severe early drop. In this

respect it stands in sharp contrast to the Baldwin, Wealthy, and many other varieties. In most years a light set of McIntosh is not serious, but in years when the set is naturally rather light, it results in serious limitation of the crop. The problem is a complicated one and it is planned to undertake some co-operative tests with various growers in these two counties in the season of 1930. It is believed that in this way information can be assembled that will help point the way to improved practices that may lessen the danger of light crops in years when the variety fails to set well.

A Study of the Storage of McIntosh Under Various Conditions. (O. C. Roberts in co-operation with C. I. Guinness of the Agricultural Engineering Department). The purpose of this study is to determine the relationship between temperature and the satisfactory storage of McIntosh apples. In conducting this experiment the apples were picked at various stages of maturity and placed in storage rooms with the temperatures at 45°, 40°, 32°, and air-cooled storage respectively. As a result of this experiment it is hoped that the maximum temperature at which McIntosh may be held satisfactorily will be determined.

Cross-Pollination and Sterility Studies with Certain Apple Varieties. (F. C. Sears, O. C. Roberts and others). Work on the cross-pollination of apple varieties was continued this year along similar lines as reported previously. McIntosh, Cortland and Northern Spy were used as the pistillate varieties. The pollen varieties included the McIntosh, Delicious Wealthy, Early McIntosh, Cortland, and Macoun. The last three, representative of McIntosh seedlings, were used especially on McIntosh. The results of this season's work showed Early McIntosh and Macoun as being of doubtful value as pollinizers for McIntosh, while Cortland was more satisfactory than the other two. However, the performance of Cortland was not as good as the previous year.

The effectiveness of the use of bouquets of suitable varieties on the set of McIntosh was studied. Two McIntosh trees were covered with tobacco cloth tents to exclude the possibility of natural pollination. A hive of bees was placed under each tree. Then a bucket containing a bouquet of Delicious, Wealthy, and Ben Davis flowers was placed in one of the trees, while in the other tree no pollen varieties were provided. The tree in which the bouquet was placed set approximately five times as many apples as the tree without the bouquet.

Studies of the Arsenical Residue on Apples. (O. C. Roberts cooperating with the Department of Entomology, and the Boston Federal Food, Drug, and Insecticide Administration). A study of the arsenical residue on apples has been continued this year as formerly with a few slight modifications. Dusts have been used in the later applications to determine if the use of such materials would control the pests and at the same time avoid an excessive deposit of arsenical residue. This appears to be a promising procedure.

DEPARTMENT OF POULTRY HUSBANDRY

J. C. Graham in Charge

Broodiness in Poultry. (F. A. Hays). The intense broody and the non-broody lines are being continued, and a considerable number of recessives lacking both genes for broodiness have appeared. As previously pointed out, there is some difficulty in increasing the population of recessives because of high mortality record. The wide variability in degree of broodiness in the broody line is receiving special attention at this time. The degree of broodiness in the flock as a whole has been reduced very significantly; first, by reducing the percentage of broody birds, and second, by decreasing the number of broody periods per individual.

The average length of the broody period has remained constant at fifteen days, throughout the history of the flock. The flock of 1927 showed only 9.5 per cent of the birds going broody as pullets. This places the flock on the same basis with respect to the broody trait as the White Leghorn.

Breeding Poultry for Egg Production. (F. A. Hays and Ruby Sanborn). The mean annual egg production of the 552 birds hatched in 1927 was 197.3 eggs. This flock was superior to previous flocks in early maturity, intensity and non-broodiness, but was slightly deficient in persistency. Records would indicate that the average decrease of eight eggs per bird was due to lack of persistency and to modifying environmental influences. The flock hatched in 1928 showed a very significant increase in vigor as measured by mortality rate in the laying house, the mean mortality rate for this flock being 14.85 per cent. The most significant increase was observed in flock hatchability for the spring of 1929, the mean percentage of fertile eggs hatched being 78, the highest in the history of the flock.

Age at first egg, body weight at first egg, high intensity and low broodiness have been well established in the flock. At the present time especial effort is being made to establish by genetic methods a flock lacking the winter pause and breeding true for genetic high persistency and high hatchability, together with maximum vigor.

Statistical Study of Heredity in Rhode Island Reds. (F. A. Hays and Ruby Sanborn). The data on the effects of inbreeding upon fecundity, covering a period from 1923 to 1928, have been assembled and submitted for publication as a Station bulletin. Eleven years' records on growth rate in Rhode Island Reds have also been assembled and are ready for publication as a Station bulletin.

A Genetic Study of Rhode Island Red Color. (F. A. Hays). Considerable progress has been noted in the establishment of desirable plumage color in the egg-laying strain of Rhode Island Reds. In the spring of 1929 a small flock of standard-bred Reds was obtained and will be used as a check against the Station strain in color breeding studies.

Determination of Genetic Laws Governing Results in Inbreeding Poultry. (F. A. Hays). A study, carried on for five years, of the effects of different degrees of inbreeding upon fecundity was concluded on March 1, 1929, and submitted for publication. The project is being carried on at present using as a foundation birds measuring up to the highest

possible standard in characteristics affecting fecundity. The matings of 1929 consisted of sire on daughters in three different groups. The matings of 1930 will be made up using half-brothers and sisters. The same rigid standard for selection will be employed as long as the experiment continues.

Heredity and Environmental Characteristics Affecting Variability in Egg Production. (F. A. Hays). Data are now being accumulated under this project, and the second-year group of daughters are now housed to be tested for laying. The selection of the 1929 breeding stock was within the three lines established by the 1928 matings. .

Factors Governing Egg Weight and Shell Character in Domestic Fowl. (F. A. Hays). The matings for 1929 in this project were made between individuals hatched in 1928 from the small, medium and large egg groups. The daughters hatched in 1928 from the mothers laying 52-gram eggs or 53-gram eggs in December did not show a significant difference in mean winter egg weight. On the other hand, the daughters from the mothers averaging 59-gram eggs in December showed a winter egg weight very superior to that of the other groups.

Egg weight in the entire flock has shown a very significant increase in the last two years. The flock hatched in 1928 reached a 24-ounce average in February. Egg weight records are now available for a complete year on 225 birds. A paper entitled the "Inheritance of Egg Weight in the Domestic Fowl" was published in the *Journal of Agricultural Research* for May 1, 1929.

Relation of Intensity or Rate of Laying to Feather Pigmentation. (F. A. Hays). Sufficient data under this project will be available next year for study. In a general way there appears to be considerable relation between intensity and shade of pigmentation in the Rhode Island Red.

DEPARTMENT OF VEGETABLE GARDENING

(Market Garden Field Station, Waltham)

Frank A. Waugh in Charge

Conditions Affecting the Production and Vegetative Propagation of Washington Asparagus. (V. A. Tiedjens). During the 1929 season investigations on the vegetative propagation of asparagus were continued. One-year-old roots weighing 160 pounds a thousand, and having crown bud development indicating high potential yielding power, were divided into two, three, four, and five or more crown sections. The results may be summarized as follows:

	Number planted	Number of skips	Number of stalks per plant	Average weight of roots Grams	Condition of growth
Whole crowns	144	0	8.4	88	Uniform height
Crowns cut in two	52	0	6.2	74	Uniform height
Crowns cut in three	52	3	5.8	62	Some variation
Crowns cut in four	78	17	6.1	50	Some variation
Crowns cut in five or more	26	2	5.5	61	Some variation

The skips in the above table are within reason except perhaps in the crowns cut in quarters. In this lot the number of skips is greater than usual. The size of the roots from the cuttings compares very favorably with the whole roots. Some of the roots from the cuttings were fully as large as the roots from the uncut crowns.

Due to the distribution and variation in size of buds on the crowns, it is impossible to make divisions so that each section from the same crown will have buds of equal size. The first buds developed on a seedling crown are much smaller than those developed late in the growing season. The small buds left over from the early seasonal growth are more or less dormant and will not produce as large a root growth as the sections having the larger buds that were developed late in the growing season. However, the potentialities for large root development are probably uniform for all the sections coming from the same root. The size of the buds on the cuttings is not necessarily correlated with the size of the stalks that follow. The size of the stalk is determined by the amount of stored food reserves in the roots attached to the section of the crown planted. The stalk may, therefore, be much smaller in diameter than the bud from which it came. The distribution of the buds on the crown determines where the crown may be divided, and thus the number of roots to the section is determined before the cutting is made. The plants that die may be accounted for by the section of the crown that they represent.

This method of propagation is feasible and applicable to commercial conditions. By this method it is possible to grow seedlings properly spaced, select 1,000 of the best out of every 10,000 roots, and increase these by crown cuttings to 3,000 or 5,000.

Comparison of Size of Roots.—A comparison between 100 two-year roots, 100 selected one-year roots, and 100 cull roots gave an average of 6.7 stalks per plant for the two-year-old roots, and 7.4 stalks for the selected one-year roots. The same number of skips, 3 per cent, was counted in each plot. In the plot of 100 cull roots the number of stalks per plant was 5.4, with 20 per cent skips. There was a big difference in height of stalks between the cull and selected one-year roots in favor of the selected roots. The two-year roots produced stalks slightly higher than the selected one-year roots.

Stem Cuttings.—An attempt was made to make stem cuttings on one and five-year-old plants. Cuttings were made from the stems below the branches having dormant buds and from the spears which had not broken open. These cuttings were grouped in four series, subjected to the following treatments, and placed in moist, sterile sand in a propagating frame.

Series I—Lot 1 immersed one hour in 3.8 per cent nitrate of soda solution; lot 2 immersed one hour in 1 per cent sodium thiocyanate solution; lot 3 immersed one hour in 3.8 per cent nitrate of soda solution plus 1 per cent corrosive sublimate solution; lot 4, check.

Series II—The time was increased to $2\frac{1}{2}$ hours.

Series III—The same as Series II but the cut ends were sealed with low temperature paraffine.

Series IV—Immersed $6\frac{1}{2}$ hours.

The spears in most cases decayed even when treated with corrosive sublimate, and proved very unsatisfactory as a source of material. None of the cuttings produced any signs of root growth, but considerable stem growth was made. The buds on the older part of the stem, that ordinarily are permanently dormant under field conditions, were stimulated to growth by the various treatments but did not show any material advantage over the check cuttings. Sodium thiocyanate for one hour was the most promising. Stalks from the one-year plants gave 30 to 50 per cent response regardless of treatment, while the stalks from five-year-old plants gave 10 to 16 per cent response in growth of dormant buds. Sealing the ends of the stems gave no material difference except to make growth slower. There was considerable difference in bud and stem growth between cuttings from one and five-year plants.

On the whole the results were interesting but gave no information on root growth. The work will be continued another year along the most promising lines.

Plant Progenies.—Selecting from individual plant progenies for higher yielding plants was continued in the Martha and Mary Washington varieties. Thirty-three lots of seed, each lot representing a plant, were planted in the field in August, 1928, and a duplicate lot planted in the greenhouse February 8, 1929. Both were transplanted in the field in April, 1929, for comparison. The roots were spaced four inches apart. They were the same size in both cases, but the greenhouse lot was transplanted with green tops. The selections sown in the field varied from 51 to 100 per cent stand, while the greenhouse lot varied from 8 to 73 per cent stand. The average number of stalks per plant was 4.5 for the greenhouse lot and 5.8 for the field lot; the average number of stalks per plant varied from 3.0 to 6.8 for the various selections. This difference is probably an indication of the inherent vigor of the various mother plants.

There is a feeling among growers that the stalks of the Mary Washington variety break over more readily than the other varieties. This was noticeable in the plant progenies, for 7 out of 12 Mary Washington selections showed a sprawly growth, while none of the 39 Martha Washington selections showed the sprawly condition. This, apparently, is a weakness in the Mary Washington variety.

Number of Seeds to the Berry.—The average number of seeds to the berry varied from three to five in the different selections. A few berries on some plants had seven and eight seeds. The weight of 100 seeds varied from 1.6 grams to 3.2 grams.

The seed from one plant was grouped in six lots according to the number of seeds in the berry and was planted. The visible growth and percentage stand were best in the lot of seed coming from the two-seed berries. The seed of each lot was weighed, and the weight of 100 seeds decreased consistently from 2.6 grams for the single-seed berry lot to 2.0 grams for the six-seed berry lot.

The seed from three other plants was divided into four sizes with sieves. The weights in each case decreased as in the previous example. In each case the second heaviest, and the second largest seed, gave the most vigorous appearing plants. For a comparison, field run seed was screened into four sizes and planted with the four plants mentioned. In

this group the growth made from the first and second largest seed was similar and did not show any advantage for the second largest seed, as was the case in the seed from the four plants. The consistency of this vigor in the second largest seed between the four plants seems to be significant and will be investigated further.

The results indicate the fallacy in comparing the effect of size of seed on plant growth by using field run seed. The variation in size of seed between plants makes it imperative that studies of this nature be conducted with seed from the same plant.

Field run seed was divided into large, medium, and small and planted three inches apart by hand in rows. The average stand (4 rows of each lot) was 61 per cent for the large seed, 70 per cent for the medium seed, and 64 per cent for the small seed. The consistency in stand in the individual rows of each lot makes the difference significant. The average number of stalks per plant for the three lots was not significantly different nor was there any difference in root growth.

Depth of Planting.—Two hundred selected one-year roots were planted 2, 4, 6, and 8 inches deep in 1928. The preliminary results are summarized in the following table:

Depth of planting Inches	Skips %	Number of plants		
		Vigorous	Medium	Weak
2	2	165	28	3
4	9	144	30	8
6	17	120	33	13
8	30	65	38	37

These results were obtained on a medium silt loam with a gravelly subsoil. Four to six inches seems to be the best depth of planting to give a good growth and have the roots deep enough so that the surface can be cultivated in the spring.

Relation of Depth of Planting Seedlings to the Angle of Crown Growth. Seedlings starting their first storage roots were transplanted to the experimental plot. After a season's growth the roots were dug and the angle of inclination for the crown growth measured.

Depth of planting Inches	Sand	Medium sand and loam	Loam
1	—14.0°	—11.6°	—13.6°
2	—10.0°	—5.8°	—1.9°
3	+6.0°	+7.1°	+1.6°
4	+11.0°	+17.0°	+6.4°

The results show that the optimum depth for planting seed was between 2 and 3 inches for the three types of soil. At that depth the new buds on the crown developed horizontally. Shallower than 2 inches, the buds tended to develop below the horizontal plane, whereas at greater depths the buds developed above the horizontal plane.

Fertilizer Studies.—In the spring of 1929 fertilizer experiments on asparagus were started in Waltham, Concord, and Eastham. Five acres are devoted to the plots. A comparison of fertilizer ingredients, time of application of fertilizers, amounts of fertilizers to apply, relation of high phosphoric acid to maturity, and relation of fertilizer to earliness, are

the main problems being investigated. Although there were variations between the plots at the end of the 1929 season, there was no correlation between the variations and the treatment of the plots. There was no consistency between duplicate and triplicate plots. The extremely dry season made it possible to locate the favorable spots in the field which were probably due to moisture.

Cold Resistance in Sweet Corn in Its Relation to Quality, Size, and Earliness. (V. A. Tiedjens). Breeding a cold resistant early yellow sweet corn was continued. A large number of ears were selected from a selfed lot of first generation seed. Considerable earliness has been incorporated in the Whipple Yellow strain used in the cross. Many of the F_1 selections were mature from two to ten days before the Whipple Yellow parent, and were fully as large.

Greenhouse Lettuce. (V. A. Tiedjens). Three pounds of the Bel-May greenhouse lettuce seed grown in 1929 were parceled out to growers in small quantities. Preliminary reports from the growers show this lettuce to be superior to Belmont and May King for greenhouse forcing.

Improvement of Vegetable Varieties Through Root and Seed Selection. (V. A. Tiedjens). Selection of foundation stock for the Field Station selection of the Wyman beet and Hutchinson carrot was continued. The demand for the Hutchinson carrot seed this year exceeded the supply by 400 pounds.

Thirty-one lots of Dwarf Horticultural beans from as many seedsmen, and fifteen lots of French Horticultural beans were compared, preliminary to establishing uniformity for these two varieties. Much mixture was found in most of the samples. Ten of the lots which showed some promise were saved for further study. There was considerable difference in earliness and susceptibility to drought between the two varieties.

Five samples of Blue Hubbard squash were secured for self-pollinating to establish a uniform variety of Blue Hubbard. A strain of Green Hubbard from the Vermont Experiment Station was grown and found to be very uniform for type characteristics. The season was not conducive to their development, however, so that the squash were under size. This was also true of the Blue Hubbard varieties.

The Genetics of Greenhouse Cucumbers. (V. A. Tiedjens). The work on this project has progressed along lines reported previously. Some crosses having commercial possibilities are being compared.

A new selection producing no pistillate flowers during the summer months and only an occasional pistillate flower during the winter months has been isolated and is being studied in crosses to determine how prevalent the sterility may become in commercial houses. The factor for this character probably had its origin in the English variety and may account for low yielding plants in commercial houses, as most of the commercial varieties carry some English "blood".

Bitter Cucumbers. Preliminary studies have been made on the relation of fertilizer treatment to bitter cucumbers. Nitrate of soda, urea, calurea, and calcium nitrate were compared with and without manure. The plants were grown in half barrels, and the chemicals were applied as top-dressing every two weeks. The first cucumbers were picked April 20, and the first bitter cucumbers occurred after May 10. The tubs receiving no

manure gave 31 per cent bitter cucumbers, while the manure tubs gave 42 per cent bitter cucumbers, with no difference between the chemical treatments. There was some correlation between bitterness and growth. Of the fancy fruit, 30 per cent were bitter; of the wasp shaped types 35 per cent were bitter; and of the seconds and nubbins 50 per cent were bitter. Generally, the more time that was required to mature the fruit, the greater was the possibility that it would become bitter. There was no correlation between the location of the cucumber on the vine and its flavor. Bottle-necked cucumbers had a 75 per cent chance of being bitter near the stem end.

DEPARTMENT OF VETERINARY SCIENCE

J. B. Lentz in Charge

The Cutaneous Vaccine for Fowl Pox. (N. J. Pyle). From the eighth to the twenty-first day following the use of vaccines, egg production was slightly decreased. In birds 68 days of age, gain of weight indicated that growth was not seriously affected and that the weaker vaccine appeared to be as efficient as the stronger, "standard" vaccine. An immunity duration of at least 371 days was established. Attenuation of the vaccine appeared to be associated with its glycerol content. Details of this work are in the printer's hands.

Laboratory Service—Pathology. (G. L. Dunlap). This service was used by 284 persons, of which number 112 made personal calls, either delivering specimens or discussing the reports of examination.

Of the 1,055 specimens examined, 1,002 represented poultry and the remainder consisted of other domesticated animals. Approximately one-fourth of the poultry specimens harbored intestinal parasites, led by coccidia. Avian tuberculosis and fowl cholera were entirely absent in the material submitted.

Trichuris ovis, a sheep parasite, and tetrameres, a poultry parasite, are being reported for the first time from this laboratory.

A diagnostic fee of two (2) dollars, to be paid before a report is issued, is associated with this service. Failure of payment accounts for 26 unclaimed reports.

This service deserves credit for valuable assistance given to the pullorum disease testing work.

Poultry Disease Elimination Law. (W. R. Hinshaw and E. F. Sanders; H. Van Roekel and K. L. Bullis). Control Series Bulletin 48 reports the 1928-29 Pullorum Disease Testing Season. Compared with the 1927-28 season, the respective increases are: 72,001 agglutination tests, 63,861 birds tested, 92 flocks, 90 negative flocks, and 72 flocks 100 per cent tested and negative. Similar comparison shows the average infection to be reduced 2.27 per cent.

The proper age to start testing birds has received some attention. Preliminary results, obtained from a limited number of flocks, seem to show that the disease can be eradicated just as efficiently when testing is begun before laying, as when testing is postponed until the flock is in production.

Among the reasons for failure to eradicate pullorum disease the following were found to have been operating in some Massachusetts flocks: not all birds on the premises were tested, retesting at intervals during the season was not practised, chicks which were hatched before the test had been completed were raised, positive birds were not removed from the flock (109 reports studied showed 84 positives left in 26 flocks), infertile eggs from untested flocks were fed, custom hatching with no discrimination against untested flocks was practised, and purchases were made without careful investigation regarding the pullorum disease status of the flock of origin.

The progress of this work has been due to no one particular factor. Poultrymen, extension workers, administrative officers, and members of the laboratory staff have appreciated the value of cooperative effort. During the year the laboratory has received 188 visitors, who wished either to discuss their own individual problems or to prepare themselves to assist other poultrymen. The Seventeenth Annual Poultry Convention, during the 1929 Farm and Home Week, gave an entire afternoon to this subject, and over 250 persons showed that close, personal contact of all concerned improves the service.

At this time no definite conclusions can be made regarding the 1929-30 season. The month of October, with over 100,000 tests, surpassed the record of any single previous month in the laboratory's history. The advantages of this early testing, to both the poultrymen and the laboratory, are so evident that no discussion is required.

Farm and Station Bang's Disease. The laboratory, in assisting this project, has recorded 972 agglutination tests.

PUBLICATION

General Bulletins

- 247 Biennial Report: For the Fiscal Years Ending Nov 30, 1927 and 1928. 55 pp. February, 1929.

The main purpose of this report is to provide an opportunity for presenting in published form, recent results from experimentation in fields or on projects where progress has not been such as to justify the general and definite conclusions necessary to meet the requirements of bulletin or printed manuscript.

- 248 Tomato Leaf-Mold: The Use of Fungicides for Its Control in Greenhouses. Guba, E. F. 24 pp. March, 1929.

The culture of greenhouse tomatoes is an important industry in Massachusetts, and the area devoted to this crop has increased considerably in recent years. Leaf-mold is the most serious disease affecting the crop. The loss of one to two months of pickings of the fall crop and one month of the spring crop as a result of this disease is common. Past recommendations regarding the proper choice of fungicides for its control are conflicting and not based on experimental evidence, and growers who have used fungicides have not obtained control. This investigation has considered the merits of different types of fungicides. An effective material, and a practical method of application, have been discovered which are recorded in this bulletin.

- 249 The Plum Curculio in Apples in Massachusetts. Whitcomb, W. D. 28 pp. March, 1929.

The plum curculio is the most injurious insect pest of apples in Massachusetts, frequently damaging more fruit than all other insects together. As a result of

the heavy loss to fruit growers, studies of this insect were begun in 1926 in the eastern part of the State, and this bulletin reports the progress of the work to date.

- 250 The Consumer Demand for Apples. Jefferson, Lorian P. 18 pp. April, 1929.

The purpose of production is the satisfaction of the requirements of consumers. In order to meet them efficiently, it is necessary to know the character and extent of the demand. This type of investigation has received comparatively little attention, but the importance of such information becomes increasingly evident. It was in the hope of benefiting both grower and dealer that this study was undertaken.

- 251 Causes of Differences in Poultry Profits. Mighell, R. L., and Branch, F. H. 19 pp. May, 1929.

Records based on experience in poultry farming show wide differences in financial returns. It is assumed that these differences can be attributed to certain specific practices and conditions which may be subject to control or modification. This study was undertaken to determine the extent to which the various factors and conditions operated and were effective in influencing profit in the industry.

- 252 Supplements for Copper Fungicides. Holland, E. B., Dunbar, C. O., and Gilligan, G. M. 20 pp. June, 1929.

Ever since copper fungicides were introduced, numerous supplementary products have been recommended for incorporation in the spray with a view to remedying some real or fancied defect. The contradictory evidence presented by different investigators relative to various supplements may be due in part to differences in amount of substance employed, in method of preparation and of application, but more often to an insufficient number of replications with different crops under varying weather and soil conditions. The use of supplements is not warranted unless they reduce infection and consequent economic losses. This study was undertaken to determine the intrinsic and relative values of the materials recommended for use as supplements.

- 253 Milk Substitutes for Calves. Lindsey, J. B., and Archibald, J. G. 9 pp. July, 1929.

The production of milk for near-by consumption is the principal industry of Massachusetts dairymen. The maintaining of the herd is an ever-present problem. Some farmers prefer to purchase mature milkers and others to rear calves from their own cows. This Station has been studying the most economical and satisfactory method of growing the calf until four months of age, and presents the results of its findings in this bulletin.

- 254 The Preparation and Effectiveness of Basic Copper Sulfate as a Fungicide. Holland, E. B., Dunbar, C. O., Gilligan, G. M., and Doran, W. L. 27 pp. June, 1929.

Copper fungicides have been a subject for investigation during the past few years. This work comprises a study of chemical composition, physical characteristics and general effectiveness in field work, together with the use of various supplementary products. The main objective was the preparation of a Bordeaux substitute that could be readily suspended in water and used as a spray, or mixed with a free-flowing carrier and applied as a dust. The product must give a practical control of disease but not necessarily equal to a highly dispersed Bordeaux of the same copper content. The advantages of such a product in the saving of time, labor and equipment in preparation, and the gain in uniformity and stability of the spray mixture are evident. Since basic sulfates are generally considered preferable to basic carbonates, attention has been directed largely to them.

- 255 Studies in Mineral Nutrition. Lindsey, J. B., and Archibald, J. G. 16 pp. November, 1929.

It was formerly held that the dairy animal obtained sufficient mineral matter from the roughages and grains consumed. More recently, based on some experimental evidence, this opinion has been questioned, and many have advised

the feeding of supplementary minerals in the form of ground bone, ground limestone and the like. In order to get additional light upon the subject, this Station has conducted experiments with growing and mature dairy animals and presents its findings in Part I of this bulletin.

As a part of the work, many determinations were made of the mineral constituents of the grains and roughages fed, and likewise of the amount found in the ordinary roughages grown in different sections of Massachusetts. These analyses are brought together in Part II of this bulletin.

- 256 **The Cost of Government in Massachusetts, 1910-1926.** Yount, Hubert W., and Sherburne, Ruth E. 68 pp. November, 1929.

The rapid increase in demand for public service, together with the resulting increase in taxes, has placed a severe strain on farmers in many Massachusetts towns. This study analyzes the costs of public service in such towns compared with larger towns and cities, and points out the more important handicaps under which small towns operate.

- 257 **The Cutaneous Vaccine for Fowl Pox.** Pyle, Norman J. 20 pp. December, 1929.

Investigation of fowl pox at this Station has for its purpose the determination of an efficient preventive and curative treatment for the disease. This is of vital importance to the Massachusetts poultry industry because the disease causes serious loss by decreasing egg production during the season when eggs are highest priced.

The study of the cutaneous vaccine, as here reported, included investigations of its efficiency, its practical use and method of administration, its action on body weight, temperature, and early egg production, and the duration of immunity which followed its administration.

- 258 **Inbreeding in Relation to Egg Production.** Hays, F. A. 48 pp. December, 1929.

For many years inbreeding has been successfully used in establishing poultry breeds where foundation stock was available only from very diverse sources. In recent years, however, work in this field has been confined largely to flocks of an established breed, and the value of inbreeding from such restricted foundation stock is questionable. The experiment here reported was planned to show the effect of various degrees of inbreeding within a so-called established breed—in this case Rhode Island Reds.

- 259 **Rate of Growth in Rhode Island Reds.** Hays, F. A., and Sanborn, Ruby. 20 pp. December, 1929.

In selecting birds for various purposes, poultrymen make extensive use of body weight as an index of the characteristics desired. The weight records presented in this report cover an eleven-year period on all living individuals in a flock bred primarily for high fecundity and show something of their significance. The results may serve as guides to the weights which may be expected in this breed if high fecundity is the chief goal, when methods of management and climatic conditions are comparable.

Control Bulletins

- 44 **Inspection of Commercial Feedstuffs.** Smith, Philip H., and others. 28 pp. November, 1928.
- 45 **Inspection of Commercial Fertilizers.** Haskins, H. D., and others. 47 pp. December, 1928.
- 46 **Inspection of Agricultural Lime Products.** Haskins, H. D., and Goodwin, M. W. 6 pp. December, 1928.
- 47 **Seed Inspection.** Smith, Philip H., and others. 11 pp. February, 1929.
- 48 **Eradication of Pullorum Disease in Massachusetts, 1928-1929.** Hinshaw, W. R., and others. 36 pp. July, 1929.
- 49 **Seed Inspection.** Smith, Philip H., and others. 55 pp. October, 1929.

- 50 Inspection of Commercial Feedstuffs. Smith, Philip H. 33 pp. November, 1929.
- 51 Inspection of Commercial Fertilizers. Haskins, H. D., and others. 61 pp. November, 1929.
- 52 Inspection of Agricultural Lime Products. Haskins, H. D., and DeRose, H. R. 8 pp. December, 1929.

Meteorological Reports

- 481-492, inclusive. Monthly reports giving daily weather records with monthly and annual summaries.

Reports of Investigation in Journals

(Numbered Contributions)

- 82 The Inheritance of Egg Weight in the Domestic Fowl. Hays, F. A. Jour. Agr. Research 38:511-519. May 1, 1929.
- 83 The Mineral Constituents of Cranberries. Morse, Fred W. Jour. Biol. Chem. 81:77-79. Jan., 1929.
- 84 Effect of Heat on Malic Acid. Morse, Fred W. Jour. Amer. Chem. Soc. 51:1276-1279. April, 1929.
- 85 Lime Penetration Resulting from Surface Application to Pasture Land. Nelson, P. R. Soil Science 27:143-146. Feb., 1929.
- 86 A Water Culture Technic for Studies in Tobacco Nutrition. Beaumont, A. B., and Larsinos, G. J. Jour. Amer. Soc. Agron. 21:150-155. Feb., 1929.
- 87 Dental Defects in Relation to Child Nutrition. Davies, Esther S. Jour. Home Econ. 21:106-107. Feb., 1929.
- 88 Monograph of the Genus *Pestalotia* De Notaris, Part I. Guba, E. F. Phytopathology 19:191-232. Mar., 1929.
- 89 Does Root Selection Accomplish Its Purpose in Asparagus Culture? Tiedjens, Victor A. Proc. Amer. Soc. Hort. Sci. 25:37-40. 1928.
- 90 Cultural Practices and Green Asparagus. Tiedjens, Victor A. Proc. Amer. Soc. Hort. Sci. 25:31-35. 1928.
- 91 An Intensive System of Grassland Management. Parsons, C. H. Amer. Soc. Anim. Prod. Proc. 1928.
- 92 The Effect of Other Crops on Tobacco. Jones, J. P. Jour. Amer. Soc. Agron. 21:118-129. Feb., 1929.
- 93 Spraying for the Control of Onion Thrips. Bourne, A. I. Jour. Econ. Ent. 22:679-683. Aug., 1929.
- 94 Observations on the Carrot Rust Fly (*Psila Rosae* Fab.) in Massachusetts. Whitecomb, W. D. Jour. Econ. Ent. 22:672-675. Aug., 1929.
- 95 The Chemical Composition of Grass from Plots Fertilized and Grazed Intensively. Archibald, J. G., and Nelson, P. R. Jour. Amer. Soc. Agron. 21:686-699. June, 1929.
- 96 The Effect of Apple Blossom Removal on Flower Bud Formation. Bailey, John S. Proc. Amer. Soc. Hort. Sci. 25:198-201. 1928.
- 97 Deficiency of Magnesium the Cause of a Chlorosis in Corn. Jones, J. P. Jour. Agr. Research 39:873-892. Dec. 1, 1929.
- 98 Effects of Soil Temperature and Reaction on Growth of Tobacco Infected and Uninfected with Black Root Rot. Doran, William L. Jour. Agr. Research 39:854-872. Dec. 1, 1929.

- 99 A Comparison of Field Methods of Determining Soil Reaction. Beaumont, A. B., and Thayer, C. H. Jour. Amer. Soc. Agron. 21:1102-1108. Nov., 1929.
- 100 Further Evidence Concerning the Significance of Nitrogen in Soil Organic Matter Relationships. Sievers, F. J. Jour. Amer. Soc. Agron. 22:10-13. Jan., 1930.

Other Contributions to Journals

(Unnumbered)

- Trends in the Dairy Industry of New England. Cance, A. E. Rpt. 3d Ann. N. E. Inst. Coop., 1929.
- Tendencies in Milk Production in Massachusetts. Sherburne, Ruth E. (Joint author). Ann. Amer. Acad. Polit. and Social Sci. March, 1929.
- Repair of Soil Filter Tubes. Larsinos, G. J., and Beaumont, A. B. Soil Sci. 27:243. 1929.
- Computation of No-Filler Fertilizer Mixtures. Beaumont, A. B., and Knudsen, H. R. Indus. and Engin. Chem. 21:385-388. 1929.
- Concentrated Fertilizers: Problems for the Chemist and Agronomist. Beaumont, A. B. Jour. Chem. Educ. 6:899-905. 1929.
- Causes of Cull Apples. Doran, W. L., and Bourne, A. I. Mass. Fruit Growers' Assoc. Rpt. 1929.
- Some Results of the Fruit Disease Survey in 1928. Doran, W. L. Mass. Fruit Growers' Assoc. Rpt. 1929.
- Lowering Weight Texture Handicaps on Plant-Packaged Ice Cream. Wright, K. E. Ice Cream Trade Jour. 25: No. 2. 1929.
- Increasing Package Acceptability. Wright, K. E. Ice Cream Field 15: No. 2. 1929.
- Frozen Fruit for Ice Cream. Mack, M. J., and Fellers, C. R. Ice Cream Trade Jour. 25: No. 8. 1929. Also, Ice Cream Field 15: No. 4. 1929.
- Utilization of Cold Packed Fruits in Ice Cream. Mack, M. J., and Fellers, C. R. Ice Cream Review 13: Nos. 1 and 2. 1929.
- A New Beneficial Insect in Massachusetts. Whitcomb, W. D. Jour. Econ. Ent. 21:937-938. 1928.
- Fruit Insects of 1928. Bourne, A. I. Mass. Fruit Growers' Assoc. Rpt. 1929.
- When Are Meats and Fish Spoiled. Fellers, C. R. Amer. Jour. Pub. Health 19::389-392. 1929.
- Cranberry Sauce Manufacture. Fellers, C. R., and Griffiths, F. P. Canning Age, Dec., 1928.
- Mincemeat, A Diversified Food Product. Fellers, C. R. Fruit Products Jour. 8:9-11. Dec., 1928.
- Simplified Sugar and Syrup Calculations for Preservers and Canners. Fellers, C. R., and Mack, M. J. Fruit Products Jour. 8:16-19. Mar., 1929.
- Utilization of Cold Packed Fruits in Frozen Dairy Products. Fellers, C. R., and Mack, M. J. Fruit Products Jour. 9:8-11. Sept., 1929; 9:46-47. Oct., 1929.
- A Canned Grapefruit Defect. Fellers, C. R. Canner, Oct. 19, 1929.
- Glass Packed Chicken. Fellers, C. R., and Griffiths, F. P. Glass Packer 2:315-318. Aug., 1929.
- Unwashed Containers as Canned Food Contaminants. Fellers, C. R. Glass Packer 1:92-94. Dec., 1928.

CHANGES IN STAFF, DECEMBER 1, 1928, TO NOVEMBER 30, 1929

Appointments

- Bullis, Kenneth L., D.V.M., Assistant Veterinary Pathologist, Poultry Disease Elimination Law, October 28, 1929.
- Gibbs, Charles S., M.S., Ph.D., Assistant Research Professor Veterinary Science, November 4, 1929.
- Hughes, Mary C., Laboratory Assistant, Pomology, October 28, 1929.
- Lindsey, Adrian H., Ph.D., Professor, Agricultural Economics, September 1, 1929.
- Shilling, Katherine E., B.S., Laboratory Assistant, Agricultural Economics, April 1, 1929.
- Van Roekel, Henry, M.S., D.V.M., Chief of Laboratory, Poultry Disease Elimination Law, August 13, 1929.
- Zielinski, John B., Jr., B.S., Junior Chemist, Fertilizer Law, October 1, 1929.

Resignations

- Barton, Rena L., Laboratory Assistant, Pomology. Died August 22, 1929.
- Brown, Marian V., B.S., Research Assistant, Farm Management, October 12, 1929.
- Dufresne, Virginia R., A.B., Laboratory Assistant, Agricultural Economics, March 1, 1929.
- Goodwin, Marvin W., B.S., Junior Chemist, Fertilizer Law, September 30, 1929.
- Griffiths, Francis P., B.S., Research Assistant, Horticultural Manufactures, transferred to Instruction March 1, 1929.
- Hinshaw, William R., M.S., V.D.M., Chief of Laboratory, Poultry Disease Elimination Law, July 31, 1929.
- Nelson, Paul R., M.S., Research Assistant, Plant and Animal Chemistry, September 21, 1929.
- Pyle, Norman J., V.M.D., Assistant Research Professor, Veterinary Science, September 30, 1929.
- Sanders, Ellmore F., D.V.M., Assistant Veterinary Pathologist, Poultry Disease Elimination Law, October 12, 1929.
- Waite, Clifton B., Collector of Blood Samples, Poultry Disease Elimination Law, September 30, 1929.

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MASSACHUSETTS
AGRICULTURAL EXPERIMENT STATION

BULLETIN No. 271

FEBRUARY, 1931

Annual Report

For the Fiscal Year Ending Nov. 30, 1930

The main purpose of this report is to provide an opportunity for presenting in published form, recent results from experimentation in fields or on projects where progress has not been such as to justify the general and definite conclusions necessary to meet the requirements of bulletin or journal.

Requests for Bulletins should be addressed to the
AGRICULTURAL EXPERIMENT STATION,
AMHERST, MASS.

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MASSACHUSETTS AGRICULTURAL EXPERIMENT STATION

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• In Charge

† At East Wareham

‡ At Waltham

A 27th 1930 A CONTENTS ---

Introduction	232
Department of Agricultural Economics:	
Consumer demand for eggs	233
The economic worth to growers of different varieties of apples	233
Competition between apples and other fruits	233
Part-time farming	234
Recreational and forestry uses of land	234
Factors affecting egg prices	234
The relation of quality factors to price of eggs	234
Competitive factors influencing the supply of market milk and cream.....	234
Analysis of market prices for Massachusetts vegetables	235
Department of Agricultural Engineering:	
Investigation of apple storages	235
Fertilizer distributors	235
Test of low-lift pumps	235
Department of Agronomy:	
Nitrogen assimilation by grasses and clovers	236
Ecological study of pasture vegetation	236
Additional pasture experiments	236
Legume variety tests	236
Methods of applying fertilizer to corn	237
Field experiments with onions	237
Nitrogen assimilation by tobacco	238
Field experiments with tobacco	238
Magnesium requirements of crops	239
Department of Bacteriology and Physiology:	
Nitrogen fixation in relation to leguminous crops	240
Laboratory service	240
The indol tolerance of the Colon-Aerogenes group of bacteria as a possible means of differentiating fecal and non-fecal strains occurring in drinking water supplies	241
Department of Botany:	
Tobacco black root-rot	241
Tobacco brown root-rot	241
A seedbed and field survey of tobacco diseases in Massachusetts.....	242
Onion diseases and use of fungicides on onions	242
Onion blast	243
Eggplant wilt	243
Cucumber downy mildew	243
Strawberry gold disease 1930	244
Tomato leaf-mold	244
Eradication of nematodes in greenhouse soils	245
Ridding soil of the narcissus nematode	245
Carnation blight	245
Plant diseases not previously reported in Massachusetts	246
Forcing gladiolus with the aid of artificial light	246
The storage of gladiolus corms	246
Influence of light quality on plant growth	247
The effect of decomposing paper on plant growth	247
Chlorosis of snapdragon caused by an excess of lime	247
The effect of temperature on the nitrate content of the soil and plant growth in the presence of decomposing cellulose	248
Temperature control tanks	248
An electric steam generator for sterilizer retorts	248
The Cranberry Station:	
Injurious and beneficial insects affecting the cranberry	249
Cranberry disease work	250
Weather observations	250
Varieties	250
Cultivated blueberries	251

Department of Dairy Industry:	
A study of packaged ice cream	252
The effect of initial cooling temperatures on gelatin in the aging of the ice cream mix	252
Factors affecting the aging time of ice cream mix	252
A study of frozen sweet cream for use in ice cream	252
The utilization of frozen fruits in ice cream	252
Use of gelatin in ice cream	253
The comparative efficiency of electrically-operated tanks versus ice in the cooling of milk	253
Department of Entomology:	
Investigation of materials which promise value in insect control	254
Control of onion thrips	256
Control of the plum curculio in apples	257
The spray residue problem	257
The biology and control of the carrot rust fly	258
Systematic study of oil sprays	258
Apple maggot control	258
Department of Farm Management:	
Enterprise relationships and farm organization on selected dairy farms in western Massachusetts	260
Types of farming in vegetable garden areas	260
Live stock management, methods and cost	260
Feed Control Service:	
Feed control	261
Seed control	261
Dairy law	261
Advanced registry testing	262
Miscellaneous work	262
Fertilizer Control Service:	
Fertilizer inspection	262
Miscellaneous analytical work	263
Vegetation pot experiments	264
Department of Floriculture:	
Study of the effect of plant nutrients on carnations and roses under glass	264
Breeding snapdragons for varietal improvement and disease resistance	265
Department of Home Economics Research:	
Present practices of Massachusetts elementary schools with regard to school feeding and transportation and their effects upon health of pupils.....	265
The comparative values of milk and tomato as supplementary feeding in a rural school	266
The value of evaporated milk for school food service	266
Department of Horticultural Manufactures:	
Extraction of fruit juices by heat	266
Manufacture and preservation of cranberry products	267
Utilization of onions by canning	267
Nitrogen distribution of the edible portion of the onion	267
Utilization of frozen fruits in ice cream	268
Pasteurization of dried fruits	268
Chemical composition of dates	268
Preservation of rodent bait	268
Department of Horticulture:	
Turf management	268
Department of Plant and Animal Chemistry:	
The effect of fertilizer and cultural treatment on the nitrogenous compounds of Havana seed leaf	269
Oil sprays	270
Nitrogen fixation in the presence of or as a result of the growth of legumes versus non-legumes under certain defined agronomic conditions.....	270
Chemical study of cranberries	271
Milk substitutes in the growing of young calves	271

Mineral requirements for the growth of dairy heifers	272
Two systems of dairy cattle feeding—high roughage and low grain v. low roughage and high grain	273
The chemical composition of grass from plots fertilized and grazed intensively	273
Department of Pomology:	
The interrelation of stock and scion in apples	274
Tree characters of fruit varieties	274
The genetic composition of peaches	274
Testing methods of pruning	275
Effect of pruning on bearing apple trees	275
Comparison of cultivation and sod in a bearing orchard	275
Comparison of clover sod and grass in sod mulch orchard	275
Tests of different amounts of nitrate of soda	275
Comparison of cultivation and heavy mulching for apples and pears.....	275
The effects of fertilizer limitation on fruit plants	276
Role of potash and lime in fruit tree nutrition	276
Effect of potash and lime on apple trees	276
Study of varieties of tree fruits	276
Fruit bud formation in the strawberry	276
Bud mutations among apples and other fruits	277
Light pruning of young grape vines	277
Work not on a project basis:	
The "set" of McIntosh apples in Middlesex and Worcester counties.....	277
Blueberry culture	277
A study of the storage of McIntosh under various conditions.....	277
Test of spray materials	277
Studies of arsenical residue on apples	278
Cross-pollination and sterility studies with certain apple varieties.....	278
Pruning of Northern Spy trees	278
Department of Poultry Husbandry:	
Broodiness in poultry	278
Breeding poultry for egg production	278
Statistical study of heredity in Rhode Island Reds	279
A genetic study of Rhode Island Red color	279
Determination of genetic laws governing results in inbreeding poultry.....	279
Heredity and environmental characteristics affecting variability in egg production	279
Factors affecting egg weight and shell character in domestic fowl.....	279
Relation of intensity or rate of laying to feather pigmentation.....	279
Department of Veterinary Science:	
Poultry disease elimination law	280
Laboratory service—pathology	280
Farm and Station Bang's disease	281
Infectious trachitis in poultry	281
The Waltham Field Station:	
The plant house	281
Electric hotbed	282
Vegetable variety trials	282
Conditions affecting the production and vegetative propagation of Washington asparagus	282
Greenhouse lettuce	283
Improvement of vegetable varieties through root and seed selection.....	283
Perennial ornamentals	283
Field Day	283
Cooperative Tobacco Investigations:	
Brown root-rot	284
Black root-rot	284
Mosaic	284
Publications	284
Changes in staff, December 1, 1929, to November 30, 1930	289

ANNUAL REPORT OF THE MASSACHUSETTS AGRICULTURAL EXPERIMENT STATION—1930

INTRODUCTION

F. J. Sievers, Director

During the past year there have been a few very significant changes in the organization of the Experiment Station and also in the type of service rendered.

What was formerly known as the Market Garden Field Station, located at Waltham, was organized primarily to support a type of research and demonstration of special value to the trucking industry, already well established in the eastern part of the State and particularly in the vicinity of Boston. Consistent with this service the work was directed by the department of vegetable gardening of the Agricultural College. In the beginning its services were largely of an extension and demonstrational nature with very little emphasis on investigation or research. With the demands for more specific fundamental information, research men in plant pathology, entomology, genetics, and floriculture were soon added to the staff with the result that the original system of administration was found not only cumbersome but no longer adequate. To correct this situation and to bring this unit of the Institution into closer and more logical relationship with the central administration, the Board of Trustees, at its June meeting, decided to change the name to the Waltham Field Station and place it under the direction of the Experiment Station at Amherst with R. M. Koon, Research Professor of Vegetable Gardening, directly in charge. This branch Station now holds the same relationship to the main Experiment Station as does the Cranberry Station at East Wareham, both of which are now organized and conducted to give major consideration to research. Conditions under the reorganization should be very nearly ideal because an opportunity is thereby afforded for four departments in the Institution, viz., botany, entomology, floriculture, and olericulture, to plan and direct certain investigations at the Field Station in Waltham through representatives of the respective departments who are in residence there.

The demands for increased service through the Field Station have been pressing for several years, and at the last legislative session these took a very definite form in the introduction and passage of a special bill providing for a liberal increase in equipment and financial support for investigations in floriculture. This new work is already well under way and it is hoped that the results will be of a nature to justify the faith placed in the Experiment Station service by those who were responsible in urging the necessary legislation.

At the Cranberry Station it has been possible to give special and increased consideration to matters influencing quality of product because of very close and satisfactory cooperation with Federal agencies. There

are evidences that here, too, as at the Waltham Field Station, there is a gradual trend toward research from work of a largely demonstrational nature.

The added facilities provided with the completion of the well-equipped horticultural manufactures building on the College campus makes possible a high quality of research work in this field. As a result the program of investigation is being gradually enlarged to include products not heretofore studied.

There is also in evidence the development of an interest on the part of commercial agencies to provide the Experiment Station with financial support for research in specific fields. Several cooperative projects supported by funds from this source are already under way. This development up to the present has proved very satisfactory both from the standpoint of the donors and of the public whom we are primarily organized to serve, and it is hoped to encourage these relationships.

The reorganization of the Graduate School in July, 1930, whereby its administration was transferred to the Director of the Experiment Station, should prove of advantage to both of these units which are organized so directly around a research program. Many phases of regularly approved Experiment Station projects lend themselves very effectively to graduate study, and already several students are working on such assignments for credit toward an advanced degree.

With the strengthening of the Extension Service program, many of the activities previously considered essential in the Experiment Station are gradually requiring less emphasis. This is evidenced especially in field work as conducted by the departments of agronomy and pomology. Many so-called investigations, which in reality are demonstrations, are being taken over by the Extension Service, where they rightly belong, thus providing the research men in these fields time for better controlled and more basic studies. Changes in this direction should of necessity be slow, but present trends indicate that they are also sure—a very encouraging sign of progress.

DEPARTMENT OF AGRICULTURAL ECONOMICS

Alexander E. Cance in Charge

Consumer Demand for Eggs. (Lorian P. Jefferson). The collection of data for this study is largely completed. General tabulations have been made but no attempt to draw conclusions as yet. The study looks to a determination of the demand for different grades of eggs, the proportion of grades handled, the opportunity for the local producer in local markets, and the differences between demand in different markets.

The Economic Worth to Growers of Different Varieties of Apples. (Lorian P. Jefferson). This study is still under way, having been planned to cover at least five years. Obviously no conclusions can be drawn until the end of the period.

Competition Between Apples and Other Fruits. (Lorian P. Jefferson). The study, involving many statistical correlations, actually reveals little direct competition between apples and any other of the most common fruits.

However, it may be questioned whether the statistical data tell the whole story. While statistics show almost no influence of the supply and price of oranges on the price of apples, it is true that the per capita consumption of apples is declining. Apparently, also, the type of demand is changing, and apples are being used for different purposes since the orange has become so largely the fruit on our breakfast tables.

The price variations of Baldwin apples in Boston are chiefly determined by three factors not related to other fruits: the size of the United States apple crop, the size of the New England crop, and the general level of prices. Of these the size of the United States crop is the most important factor.

The price of McIntosh apples is, however, little influenced by the total volume of apples on the market or by New England production, but is markedly affected by the general level and trend of prices. Correlations of supply and price of various other fruits with the price of McIntosh indicate that no one of these has any noticeable influence.

Part-Time Farming. (David Rozman) The project on part-time farming has been completed and the material published as Bulletin 266.

Recreational and Forestry Uses of Land. (David Rozman). Data on land values, taxation, and area held by non-residents were secured from the assessors' books in 71 towns, representing 25 per cent of all towns in the State with a population of less than 10,000. This material is now being tabulated and analyzed as to its bearing on the problems of land utilization.

Detailed information on land utilization was obtained in several towns through personal interviews with assessors, town clerks, real-estate men, and other local people. No definite conclusions from this study will be available until completion of the field work during the next spring.

Factors Affecting Egg Prices. (A. H. Lindsey). Wholesale price quotations on the Boston market were used for the basic material of this study. Lack of purchasing power in 1929 and 1930 caused the trend of egg prices, which was already downward, to turn even more sharply downward. The improvement in quality of western eggs has not seriously affected the favorable differential which has existed between prices of western and nearby eggs.

A formula for forecasting peak prices of eggs in November from data on June first has been worked out with an accuracy in results of within two cents, two years out of three. The average price of eggs in April may also be forecast from October—December data with an accuracy of within 2.8 cents in two-thirds of the cases.

The Relation of Quality Factors to Price of Eggs. (A. H. Lindsey). Quality factors used were air cell, weight, condition of yolk, condition of white. Prices were found by purchase of eggs from retail stores in Boston. Three periods were studied—April, August, and November. Weight was of much greater significance in April than in November. Air space was most important in November. Condition of yolk was most important in April. The combined effect of all quality factors on price was of greatest importance in August.

Competitive Factors Influencing the Supply of Market Milk and Cream. (A. H. Lindsey). A study of the Worcester milk shed was made from

records of the City Inspector's Office. Changes in price and inspection had very little influence in changing the milk-shed area. More milk is being produced at great distances from the city and less in the vicinity of the city. The consumption of quality milk is increasing.

Analysis of Market Prices for Massachusetts Vegetables. (H. B. Rowe). A preliminary analysis has been made of the price and supply data which were tabulated last year for ten of the more important vegetables on the Boston market, and a more complete study of asparagus prices has been practically completed. The preliminary analyses indicate that valuable results may be expected for all but two of the ten crops. The asparagus study has furnished quantitative measurements of the relationship between local prices and the two most important price factors, local supply and shipped-in supply, during the period just preceding the local marketing season. Knowledge of these relationships makes possible the interpretation of outlook for local producers, with a degree of accuracy and reliability which could not be attained heretofore.

DEPARTMENT OF AGRICULTURAL ENGINEERING

C. I. Gunness in Charge

Investigation of Apple Storages. (C. I. Gunness). The investigation of mechanically refrigerated storages has been carried on this year along two distinct lines. The phase pertaining to the temperature requirements for satisfactory storage has been continued in cooperation with the Department of Pomology. The results of two years' observation will be available at the end of the present storage season.

The study of another phase of the storage problem was made possible this year through the fact that three fruit growers installed mechanical refrigeration on their farms, and careful observation has been made of the operation of these storages. Different types of equipment have been installed in these various storages, and it has been possible to observe the effect of various types of equipment on the stored fruit. Data on the cost of operation of the various storages are being collected.

Fertilizer Distributors. (C. I. Gunness). Very little work has been done on this project during the present year. It is hoped that more time can be given to this project during 1931.

Test of Low-Lift Pumps. (C. I. Gunness). During the past summer a testing plant was built at the Cranberry Station at East Wareham for the testing of low-lift pumps. This was completed in August, and one pump was tested. The publication of the results will be delayed until additional pumps can be tested.

DEPARTMENT OF AGRONOMY

A. B. Beaumont in Charge

Nitrogen Assimilation by Grasses and Clovers. (A. B. Beaumont and G. Rohde). Additional evidence obtained from solution cultures showed that blue grass, timothy, redbtop, English rye grass, and red and alsike clovers assimilated nitrate nitrogen better than that from ammonium sulfate and urea, as judged by growth. In the early stages there was little difference in the growth of the several grasses, but differences appeared in the later stages. With the clovers, the differences due to form of nitrogen appeared earlier and were more pronounced.

Ecological Study of Pasture Vegetation. (A. B. Beaumont, E. F. Gaskill and R. W. Donaldson). The old experiments have been continued and new ones added for the purpose of comparing different carriers of nitrogen and different amounts of lime and other calcium compounds. Results of this year indicate that very little effect may be expected from minerals (lime, phosphoric acid and potash) the same year they are applied as a top-dressing, whereas all forms of nitrogen used are more or less effective the first year. Similar evidence regarding response to minerals and a nitrogen fertilizer (Chilean nitrate of soda) were obtained from ten outlying fields in Worcester County.

Additional Pasture Experiments. (A. B. Beaumont, R. E. Stitt and R. C. Foley). In a palatability test it was found that two Holstein cows chose pasturage as follows: (1), white clover; (2), timothy; (3), redbtop; (4), blue grass. There was little if any effect of different fertilizer treatments on palatability although there was some indication that grass from plots which received the largest amount of nitrogen was preferred by the animals. On certain of the Hohenheim plots it was likewise observed that seedlings containing a high proportion of timothy were preferred by dairy animals.

In an experiment in which two carriers of nitrogen were used as top-dressing for a mossy pasture, it was observed that Chilean nitrate of soda acted as a mild toxin for moss. To a considerable extent moss was permanently killed without injuring the desirable vegetation.

Legume Variety Tests. (A. B. Beaumont and R. E. Stitt, cooperating with E. A. Hollowell, Bur. of Plant Indus. U. S. D. A.).

Alfalfa.—Test No. 1 was brought to a close on account of weediness, and the field plowed after spring data on stand were obtained. These data were in substantial agreement with those reported last year. The experiment has shown that for a period of at least three years the common varieties of alfalfa coming from such states as Utah, Kansas, and the Dakotas may be expected to be in the same class as Grimm and other variegated varieties as respects winter-hardiness. Test No. 2 also was terminated on account of weediness (mainly grasses). This test has given data on winter-hardiness similar to those of Test No. 1, but covering more varieties. Ludak, Turkestan and Arizona were definitely poor in stand after two winters; California, South African, and Colorado were good; and Grimm, Ontario, Hungarian, Dakota Common, Hardigan, Disco, New Mexico, Italian, Utah, Kansas, and French were the best.

Further, this test has demonstrated that it is unwise to seed alfalfa on sod land in Massachusetts without the intervention of at least one year of tilled crop or fallow to kill troublesome weeds, especially the grasses. From Test No. 3, seeded in 1929, data on stand and yield were obtained this year. Yields per acre for two cuttings, one year after seeding were:

4-5 tons; Ontario, Hardigan, Dakota Common, Hungarian, Italian.

3-4 tons: Dakota 12, Disco, Utah, Argentine, Nebraska, Turkestan, Kansas, New Mexico, Ladak.

2-3 tons: Arizona, South African.

1-2 tons: Hairy Peruvian.

Soy beans.—Of 20 varieties of soy beans, the following 10 yielded the most hay in decreasing order: Dunfield, Manchu, Habaro, Mansoy, Virginia, Medium Green, Harbinsoy, George Washington, Illini, Pinpu. Seven of these were among the highest yielding 10 varieties of last year.

Field Peas.—Of 5 varieties tested, Chang led in yield of hay, followed by Golden Vine, O. A. C. 181, Wisconsin Common, and Multiplier, in order.

Vetch.—Spring sown vetch varieties yielded hay in the following order: Oregon Pearl, Oregon Common, Smooth (15851), Hungarian, Hairy (15760).

None of these annual legumes—soy beans, field peas, vetch—with only one cutting, yielded as much hay as well-adapted alfalfa varieties with two or more cuttings a season according to these tests. Therefore, it appears that such annual legumes should be considered mainly as emergency substitutes for the higher-yielding alfalfa and clovers.

Method of Applying Fertilizer to Corn. (A. B. Beaumont, E. F. Gaskill and R. E. Stitt). This is the third consecutive year that a field test of methods of applying fertilizer to corn has been made. The work was done according to a plan for cooperative work sponsored by a joint committee representing the American Society of Agronomy, National Society of Farm Equipment Manufacturers, American Society of Agricultural Engineers, and National Fertilizer Association. The results of this year are in general agreement with those of preceding years; namely, that fertilizer applied in the hill gives better results than the same, and in some cases, larger amounts broadcast. Fertilizer applied in the hill at the rate of 500 pounds was superior to 500 pounds or 1000 pounds broadcast.

Field Experiments with Onions. (A. B. Beaumont and M. E. Snell). Most of these experiments were redirected last spring in the light of results of the last five years. The crop was started from sets instead of seeds as in previous years. Cover crops were omitted this year, the comparison of muriate and sulfate of potash was dropped, and certain changes were made in the study of fertilizer ratios.

In the lime series, where lime was applied in 1925, there was a progressive increase in yield from applications of 2 up to 6 tons of limestone per acre. In two other series one of which received lime in 1925, the other in 1928, the yield from the later application was superior to that from the earlier, indicating that when lime is used in moderate amounts, the applications should be more frequent. Experiments on the substitution of superphosphate for a part of the lime gave results which indicate that superphosphate can take the place of little if any of the required lime, and at present prices of these materials there would be no economy in the sub-

stitution. All the experiments thus far indicate that lime is indispensable for successful onion production on the soils of the Connecticut Valley.

In the old fertilizer ratio series, the 4-12-8, which has led in former years, was inferior to the 4-8-4 and about equal to the 4-8-8. (Figures refer to percentages of NH_4 (old basis), P_2O_5 , and K_2O , respectively.) The highest yield was from the 4-8-4 with later side dressing of nitrate of soda equivalent to a 2-0-0, and the lowest from 2-12-8. It is quite possible that the substitution of sets for seed influenced the effect of fertilizers. The 4-7-4 with a side dressing of fish (2-1-0) gave a low yield. These results with additional nitrogen as side dressing are similar to those of last year, but cannot be explained in the same way; last year was unusually dry, while in 1930 the rainfall during the growing period of the onions (sets) was slightly above normal. In the lime series the 4-12-8 was superior to the 4-8-4, and in the old cover crop series the 4-12-8 was superior to the 6-8-8. Considering the results of this experiment for the six years of its duration, it would seem that for land which has not been intensively fertilized for several years previously, a fertilizer high in phosphoric acid and potash, something like a 4-12-8, is needed for at least the first several years of onion growing. Fertilizer has been applied at the rate of 2500 pounds per acre, a comparatively high rate, and it is quite probable that a cumulative effect of previous years is beginning to manifest itself.

A field experiment with onion sets of three size groups demonstrated the superiority of sets of medium size. Sets from one-half to three-fourths inch in diameter yielded almost twice as much as those one-fourth to one-half inch, and slightly more than those three-fourths to one inch. The medium group threw less than 1 per cent seed stalks, the large sizes 72.9 per cent, and the smallest none. The largest sets produced 33.0 per cent multiple bulbs, medium sets 1.4 per cent, and smallest sets 0.12 per cent. About three times as many bushels were required to plant an acre with large sets as with medium-sized sets. Altogether, the results were strikingly in favor of medium sets.

Onion breeding work was continued on lines previously described.

Nitrogen Assimilation by Tobacco. (A. B. Beaumont and G. Rohde). Further evidence has been secured from solution cultures which supports statements made in the last report that nitrogen in the form of nitrates is better assimilated than in the form of ammonia, urea, and certain organic forms. This nutritive relation prevails when the entire growing period of the plant is considered, although there appear to be stages of growth when ammonia is assimilated as well as nitrate, if not better.

Field Experiments with Tobacco. (A. B. Beaumont and M. E. Snell). 1930 has been the best year for the growth of tobacco since the field experiments were started seven years ago, with the best plots producing slightly more than 1 ton of cured leaf per acre, and all plots averaging around 1800 pounds per acre. The highest yield, averaging 1998 pounds per acre, was from a series of 10 plots which received 2625 pounds of tobacco fertilizer analyzing 4.1 per cent N, 4.0 per cent P_2O_5 , and 5.0 per cent K_2O , and 10 tons of manure. Five plots which had a cover crop of redtop were next with an average yield of 1936 pounds, followed by those which had timothy and rye as cover crops. As in previous years, tobacco yields were poorest in the animal husbandry rotation (corn, timothy or clover, and tobacco), yields being 1201 pounds after timothy and 1326

after clover. It has now been established that this particular rotation is unsuitable for tobacco, producing symptoms of a malady known as brown root-rot. It remains to determine the underlying causes of the effect, and efforts are now directed particularly to that study. With that in mind the field experiments were redirected in the spring of 1930, the cash-crop rotation being replaced by a duplication of the animal husbandry rotation, and the so-called "criss-cross" rotations dropped.

In an experiment involving different quantities of nitrogen, phosphoric acid and potash remaining constant, 164.5 pounds nitrogen per acre (200 pounds ammonia) gave the highest yield, followed in order by 205.6, 123.4 and 61.7 pounds nitrogen. From this and previous years it seems that for Massachusetts conditions 100 to 150 pounds of nitrogen are necessary for maximum yields of tobacco.

In a further comparison of different carriers of nitrogen, ammonium sulfate produced more tobacco than sodium nitrate, cottonseed meal or the regular mixture containing several forms of nitrogen. Furthermore, and of particular interest in view of results of previous years and other experiments, yields were slightly greater from plots which had one year of timothy preceding tobacco than from the plots which had tobacco the previous year. However, all yields were good.

The following miscellaneous tests were made on a small scale, too small to give more than indicative results:

(1) Both Nitrophoska (15-30-15) and regular tobacco fertilizer containing considerable cottonseed meal, plus magnesium sulfate, failed to produce normal crops of tobacco without lime, when used on a very acid soil (pH about 4.5).

(2) With potash omitted from the regular tobacco fertilizer, but supplied in ground tobacco stems, a good yield of tobacco was obtained.

(3) Colloidal phosphate at rates of 1000 and 2000 pounds per acre, in addition to the regular fertilizer mixture, slightly increased yield.

(4) Milorganite, an organic fertilizer made from processed sewage, proved a good substitute for the more expensive cottonseed meal, producing 1801 pounds per acre. It remains to be seen what the quality of the crop will be.

(5) Fertilizer applied in the row produced slightly more than an equal amount applied broadcast. One-half the standard ration in the row produced 1663 pounds, which compares with 1859 pounds from a full ration broadcast. This is the first year of this experiment and results are only indicative; but in view of results from a similar experiment with corn, it is worth repeating.

Magnesium Requirements of Crops. (A. B. Beaumont and M. E. Snell). This investigation was continued in pot and field experiments according to plans made by J. P. Jones. No outstanding symptoms or depression of yields were obtained in either case. It is now suspected that, except in cases of exceptional deficiency in soil magnesium, plants will hardly be affected in dry years or the next year or two following dry years, owing to the supply of native magnesium through the natural weathering processes. It is planned to continue this investigation.

DEPARTMENT OF BACTERIOLOGY AND PHYSIOLOGY

G. E. Gage in Charge

Nitrogen-Fixation in Relation to Leguminous Crops. (James E. Fuller). Previous work on phases of this subject has been reported during the past year in *Soil Science*, Volume 30, July, 1930, under title of "Nitrogen-Fixation in Field Soil under Different Conditions of Cropping and Soil Treatment." During the course of this investigation the data indicated the possibility that the lime applied may have been responsible for the variations in the amount of nitrogen fixed by the soil from the different plots of the field. The hydrogen-ion concentration of the soil from the various plots showed no marked variation, although the quantity of lime applied varied widely. Therefore, there is a possibility that lime may have some relation to *Azotobacter* metabolism other than the neutralization of acidity.

Synthetic media have been studied in the laboratory during the year to ascertain the influence of different calcium compounds on the amount of nitrogen fixed by the different strains of *Azotobacter*. These experiments are being repeated. Plant-house experiments are being conducted in which soil is treated with the calcium compounds employed in the synthetic media, these compounds including salts varying in their ability to neutralize acids. The purpose of the investigation is to study the influence of the calcium in the presence and absence of combined nitrogen.

Another phase of this project has had to do with distribution of cellulose-decomposing activity in the soil of the experimental field. The data at present appear to correlate the nitrogen-fixing activity of the soil from the different plots of the field.

Besides work on this project, a cooperative experiment has been in progress with the Department of Botany. This has had to do with the effect of temperature on the utilization of nitrates by cellulose-decomposing organisms. The data obtained thus far indicate that from the laboratory standpoint soil known to contain active cellulose-decomposing organisms will bring about decomposition of cellulose within a certain space of time. Decomposition was less active at temperatures below 15° C. Data from the pot experiments will be found in the report of the Department of Botany.

Laboratory Service. (Ralph L. France). During the past year the Laboratory Service has given assistance to local milk inspectors and milk dealers throughout the Connecticut Valley. Towns and a few cities have called upon the laboratory for monthly tests of all milk sold within their boundaries. This phase of service has grown into a health control service not only through the medium of laboratory tests but also through information given in personal interviews with dealers and inspectors and by inspections of dairy barns.

Samples of water from private supplies from many parts of the State have been submitted for bacteriological analysis to establish their purity for drinking purposes. Fifty per cent of all the samples analyzed during the year were unsafe for human consumption. This condition shows no great improvement over previous years, and indicates that there is need for active education concerning the location and construction of rural

water supplies. It might be of value, if the laboratory appropriation could be increased sufficiently to finance the undertaking, to make sanitary inspection of the water supply and environment in some of these districts having unsafe water.

The legume culture collection has been kept intact and propagated as in past years, for the purpose of distributing to farmers needing this material for legume inoculation. Nearly all cultures furnished were for inoculating alfalfa.

The miscellaneous examinations made during the year include examinations of milk for garget, streptococci and other organisms causing inflammation of the udder, chemical analyses of milk, and examination of food products for organisms causing unnatural spoilage.

The Indol Tolerance of the Colon-Aerogenes Group of Bacteria as a Possible Means of Differentiating Fecal and Non-Fecal Strains Occurring in Drinking Water Supplies. (Ralph L. France). The work to date indicates that in order to establish a more uniform set of results for the determination of the possible use of the indol tolerance as a test, it is necessary to make some changes in methods and a more complete study of the biochemical activities of the various strains. With these studies followed through, it is anticipated that the difficulties already expressed may be eliminated, making it possible to obtain more consistent results.

DEPARTMENT OF BOTANY

A. Vincent Osmun in charge

Tobacco Black Root-Rot. (W. L. Doran). Soil in plots last limed in 1923 still had pH values favorable to infection by *Thielavia* in 1930. Neither alfalfa nor timothy was more effective than tobacco in lowering the pH value of over-limed soil. Soil acidity of limed plots was increased somewhat even four years after the application of sulfur. As in previous years, there was less black root-rot in limed plots to which sulfur or acids were applied in 1926 and 1927 than in limed plots not acidified.

There was not much, if any, less black root-rot of tobacco following the hay crops than in plots of continuous tobacco.

Yields of tobacco in plots limed were 27 per cent less than yields in plots not limed. Loss caused by lime applied in 1923, has been decreasing since 1925. Increased yields in limed plots resulting from the application of acids or sulfur were less in 1930 than in earlier years.

The application of sulfur to a field in which the soil had an initial pH value of 7.1 lowered the pH value to 6.5, but this was not enough to affect black root-rot or growth of tobacco.

An application of orthophosphoric acid lowered a soil pH value from 5.9 to 5.0, but black root-rot was nevertheless severe. It is apparent that other factors than or in addition to the hydrogen ion concentration of the soil are concerned.

Tobacco Brown Root-Rot. (W. L. Doran). In the second or third year of tobacco following alfalfa, timothy or alsike clover, there was little and in most cases no brown root-rot. The brown root-rot effect of these hay

crops on the tobacco which followed them disappeared after the first year or two of tobacco.

Assuming, for hypothetical purposes, that brown root-rot is associated with certain soil microorganisms, which may result in a deficiency of nitrogen and (or) the formation of toxic substances in the soil, it is conceivably possible that certain inorganic salts applied to soil might inhibit such microorganisms or might inactivate, chemically, such toxic substances. Copper oxide, copper sulfate, copper acetate, lead sulfate, or lead acetate were applied in varying amounts to brown root-rot soil (timothy sod), and in it tobacco was grown. These salts of copper and lead, in the amounts used, were all somewhat toxic to tobacco plants.

Since brown root-rot is worse in some soils than in others, under the same cropping system, work is now in progress with the object of finding some of the relations between brown root-rot and certain characteristics of the soil, including total nitrogen, P_2O_5 , organic matter, soluble iron and aluminum, mechanical condition, and water-holding capacity. The chemical work involved is being done in the Fertilizer Control Laboratory, and tobacco is being grown in all (12) soils.

A Seedbed and Field Survey of Tobacco Diseases in Massachusetts. (W. H. Davis, O. C. Boyd, and W. L. Doran). In a tobacco disease survey of the State, 50 seedbeds and about 100 representative fields were inspected. The results may be briefly summarized as follows:

Seedbed Survey

- (1) The soil was sterilized in 25 per cent of the seedbeds.
- (2) Twenty per cent of the seedbeds were sprayed or dusted; this practice was followed by nearly everyone planting ten acres or more.
- (3) Growers who sterilized their seedbeds were rewarded with superior plants and fewer losses in the crop from wildfire, mosaic and other diseases.
- (4) In one instance where a few plants from a bed infected with wildfire were transplanted to a fourteen-acre field, 30 per cent of the plants in the field became infected, causing appreciable loss at harvest.
- (5) Growers who have their seed "blown" believed it to be a good investment, permitting use of less seed and insuring better and earlier plants.

Field Survey

- (1) Wildfire was found in all fields inspected, except ten, with losses from a trace to 20 per cent.
- (2) Angular leaf-spot caused by a bacterium (*B. angulatum*) and new to most of the growers was located throughout the area.
- (3) Mosaic or calico was the most prevalent disease, as it occurred in nearly every field.

Onion Diseases and Use of Fungicides on Onions. (W. L. Doran). In cooperation with A. I. Bourne, systematic observations were again made in many onion fields, and for the second year spraying and dusting experiments were conducted. There was neither blast nor mildew here in 1930.

Yields were not affected by copper lime dust; but were increased 13 or 16 per cent by Bordeaux mixture 4-4-50, applied 4 or 6 times, respectively, and 17 or 24 per cent by Bordeaux mixture 8-4-50, applied 3 times or twice, respectively.

Onion Blast (L. H. Jones). By artificially controlling the environment of growing onions, it was possible to produce an injury to the plants resembling blast. Reduced light, high relative humidity, and a wet soil for a period of ten days was sufficient to make the plants blast when exposed for a few hours to intense sunshine and an atmosphere of low relative humidity. Absence of blast in the field this year precluded the possibility of comparison with that condition as it occurs naturally.

Eggplant Wilt. (E. F. Guba, Waltham). Since the last report, study has been confined to the pH relations of the causal organism and host. On slides in Petri dishes aluminum sulfate in 1-100 to 1-500 dilutions, inoculated sulfur, and monohydrated copper-lime dust (20-80) destroyed the viability of the spores. Nutrient media acidulated with sulfuric acid completely inhibited growth of the pathogene at pH 3.7, and the rate of growth increased in proportion to an increase in the pH value of the growing medium. Retardation of growth occurred below pH 4.5. However, the increase in growth of the pathogene due to but slight decreases in acidity between pH 4.0 and 4.5 was significant.

Aluminum sulfate and inoculated sulfur were compared with respect to their effect upon the growth of eggplants and the control of the disease. Wooden boxes holding four gallons of soil were used and the acidifying agents were added in increasing quantities. Inoculated sulfur produced a rapid increase in acidity, while at least three times as much aluminum sulfate was required to obtain the same effect. With aluminum sulfate, a range of pH 4.7-5.0 showed no effect upon the growth of eggplants. Infection occurred at pH 5.0 and higher. Below pH 4.7 growth became poorer as the pH value of the soil decreased. With inoculated sulfur, all of the plants were infected at a soil pH of 4.3, and one-third of them at pH 4.0. At pH 4.0 growth was fair, and at pH 3.5-3.6 the plants were killed.

The effect of field applications of chemicals on the control of the disease and the growth of the host was studied. The plants were grown in soil sterilized with formaldehyde, and the field to which the chemicals were applied had been used for eggplants for four years in succession. The results revealed the failure of inoculated sulfur and aluminum sulfate to control the disease when applied at a rate in excess of the tolerance of the host. No results were secured which could be construed as a basis for suggesting acidification of infested soil as a method of controlling eggplant wilt. In the experiment reported, eggplants on land in sod for five years gave the best growth and the best yield in spite of the high percentage of infection. The existing practice of using old sod for eggplants remains the only reliable and practical method of control.

Cucumber Downy Mildew. (W. L. Doran). The weather of the season seems to have little relation to the date of the first appearance of this disease in the field. In six consecutive years (1925-1930), downy mildew has always appeared here within the first two weeks of August.

Bodies resembling oospores have been found, but attempts to germinate them or cause infection with them were without result. The means of overwintering of *Peronoplasmopara cubensis*, therefore, remains undetermined.

It was found that conidia produced in any dewy night do not live after the sun dries the dew in the morning. Infection in the absence of rain, there-

fore, must occur the same night or the same morning as that in which sporulation has brought the infecting conidia into existence.

Greenhouse cucumbers were injured by dusting with sulfur but not by spraying with Bordeaux mixture 1-1-50, 1-5-50, 2-2-50, 2-10-50, 4-4-50, 3-10-50, or 4-0.8-50, nor by copper acetate, Pickering spray, or milk of lime.

Cucumbers which had been sprayed, the day before, with Bordeaux mixture 1-1-50, 2-2-50, 2-10-50, 3-3-50, and 3-10-50 were inoculated with a suspension of the conidia of *P. cubensis* in water. There was no infection of any of the plants so treated, although every leaf of check (unsprayed) plants became infected. In the greenhouse, Bordeaux mixture, 1-1-50 is probably adequate in preventing infection of cucumbers by this fungus.

Strawberry Gold Disease 1930. (E. F. Guba, Waltham). Experiments are under way to determine the nature and manner of spread of the disease. The possible relation of insects to infection is being determined by W. D. Whitcomb. The value of roguing and the selection of healthy plants for the succeeding planting are being considered as means of control. Data from the experiments undertaken will be available in 1931.

Tomato Leaf-Mold. (E. F. Guba, Waltham). Work on this project during the year has been confined to demonstrations of the control of the disease through air management based on knowledge of the temperature and humidity relations of the fungus. Adequate air circulation to prevent excessive temperatures and to insure rapid removal of water of transpiration from the leaf surfaces is essential to the control of the disease. From June to September, inclusive, when heating is not practiced, inside conditions should parallel outside conditions as nearly as possible; likewise during warm intervals in May and October, and when the outside temperature does not drop below 50°F. With a daily minimum of less than 50° F. outside, heat to provide an inside temperature of 60°-65° F. with a little ventilation is important. After the middle of November ventilation is not necessary so long as the inside temperature is less than 80° F.

Old-type greenhouses often lack adequate means of ventilation. Experiments have shown that for these houses especially, and for modern types where hand control is not efficient, automatic control of humidity will remove the disease as a factor so far as it influences the yield. The system involves a series of exhaust fans and pipe heat, the movement of the former and the flow of the latter called for independently or in unison by a hygrostat, set (for tomato leaf-mold) to demand heat and exhaust air when a maximum relative humidity of 80 per cent is reached. A low thermostat set at 60° F. guarantees the minimum growing temperature, and a high thermostat set at 70° F. determines the range of temperature within which heat may be expected to operate the hygrostat for its control of the humidity. Above this range the humidity is controlled by the exhaustion of air only. Ventilation was necessary only as the inside temperature rose above 70° F. In the fall and winter of 1929-30, automatic humidity control gave 17 per cent less infected foliage than automatic temperature control, and in the fall and winter of 1930-31 (up to December 1) 10 per cent less than automatic temperature control. Since the comparison was made with conditions which were subjected to careful hand control except for temperature which was automatically regulated, and in a greenhouse with ample ventilating area, the small difference in favor of automatic humidity control is significant.

Eradication of Nematodes in Greenhouse Soils. (L. H. Jones). A mixture of equal parts by weight of calcium cyanide (Cyanogas) with paradichlorobenzene, incorporated in the soil of a ground bed in two applications with an interval of seven days, successfully eradicated nematodes. Each application was at the rate of 2400 pounds per acre. Twenty-nine days after the second application, tomatoes were planted in the bed. The first crop was adversely affected by the paradichlorobenzene. The second crop was excellent, both in foliage growth and production. The bed has remained free from nematodes for more than a year while beds on either side have been severely infested. Though this treatment is not practical, the results seem to promise some measure of success for the effort to apply the principle of dry chemical applications to the eradication of nematodes in the soil.

Ridding Soil of the Narcissus Nematode. (L. H. Jones). The narcissus nematode (*Tylenchus dipsaci*) is quite distinct from the parasitic species found in greenhouse soils. The former has been eradicated by treatments that failed entirely when used against the greenhouse nematode. Soil infested with the narcissus nematode was freed of this organism by each of the following treatments: steam in one application, chloropicrin (tear gas) in one treatment, Cyanogas in two treatments, and a combination of Cyanogas and paradichlorobenzene in one treatment. Narcissus was grown on the treated soils and the bulbs stored until autumn. Efficacy of the treatments was determined by examination of the bulbs.

Carnation Blight. (E. F. Guba, Waltham). The causal fungus (*Alternaria dianthi* S. & H.) does not survive the second winter in the field, indicating the importance of a two-year rotation. Commercial varieties show different degrees of susceptibility to blight, and the reaction of all types to the disease has been carefully studied. In general, the Matchless and related broad-leaved types are very susceptible.

The early occurrence of the disease is often noted in the propagating house and in the flats, but the value of Bordeaux treatments could not be shown in the absence of disease as a factor where the experiments were conducted in 1930. Injuries to the leaf tissue by red spider, artificially with the needle, and by the knife were shown to favor infection of the leaves. Pruning the cuttings, therefore, increased the danger of infection.

Laboratory experiments with fungicides have demonstrated the superiority of Bordeaux mixture and calcium arsenate sprays in preventing germination of the spores and infection of potted plants. A variety of dust mixtures containing combinations of naphthalene, copper sulfate and calcium arsenate in combination with lime or sulfur as fillers prevented spore germination, but on potted plants the most effective protection against infection was obtained with dust mixtures containing calcium arsenate. Of the dusting mixtures used in the field, calcium arsenate, monohydrated copper sulfate and lime gave the best results; but better control was obtained with copper sprays; e.g., Hammond's copper solution, sal soda Bordeaux and caustic soda Bordeaux. Sal soda Bordeaux proved superior to the other sprays used, but none of the sprays or dusts used in 1930 gave satisfactory control of the disease.

Experiments in progress show that loss from disease after the plants are housed is influenced by the prevalence of disease on the plants in the field,

late benching, overhead watering for controlling red spider, over-watering, and high house temperatures. A comparison of overhead watering and naphthalene fumigation for combating red spider showed 27 per cent increase in production of flowers in favor of naphthalene fumigation. The difference is attributed to a higher mortality of plants from *Alternaria* and *Fusarium* where water sprays were used for controlling red spider, and to better growth among plants subjected to naphthalene fumigation, resulting from particular house atmospheric conditions attendant with the use of naphthalene.

Plant Diseases not Previously Reported in Massachusetts. (O. C. Boyd and W. H. Davis). Leaf-blight of corn, caused by *Helminthosporium turcicum* Pass., on Golden Bantam, Yellow Dent, Stowell's Evergreen; leaf-spot of *Lupinus polyphyllus*, caused by *Alternaria* sp.; Botrytis wilt of *Lupinus polyphyllus*, caused by *Botrytis vulgaris* Fr.; fruit-drop of grape, caused by *Pestalotia uvicola* Speg., especially severe on Brighton grape; twig-blight of American bladdernut, caused by *Coryneum microstictum* Berk. & Br.; rust of Iris sp., caused by *Puccinia iridis* (DC.) Rabh.; halo blight of Lima bean, caused by *Bacterium medicaginis* (Sack.) EFS. *phaseolicola* Burk.; bacterial leaf-spot of cabbage and cauliflower, caused by *Bacterium maculicolum* McC. (apparently); angular leaf-spot of cucumber, caused by *Bacterium lachrymans* Smith & Bryan; bacterial leaf-speck of muskmellon, undescribed and undetermined; bacterial leaf-spot of summer squash, caused by *Bacterium cucurbitae* Bryan; leaf and fruit-spot of pepper, caused by *Bacterium vesicatorium* E. M. Doidge; bacterial wilt and root-rot of alfalfa, caused by *Aphanobacter insidiosum* McC.; stem-rot of sweet clover, caused by *Corticium vagum* Berk. & Curt.; limb canker of blue spruce, caused by *Cytospora* sp., previously observed for many years but cause not determined; wilt of Japanese barberry, caused by *Verticillium albo-atrum* Reinke & Berth.; bud-blight of Gardenia, cause undetermined, associated with the presence of mealybugs and probably bacterial; bacterial blight of soy bean, caused by *Bacterium sojae* Wolf.; leaf-spot of Zinnia (Bacterial; undet.); ring-spot of tobacco (Virus).

Forcing Gladiolus with the Aid of Artificial Light. (L. H. Jones). Gladiolus corms of the variety Crimson Glow, kept in cold storage during the summer, were planted August 21 and September 11. All plants received the normal daylight under glass. Half the plots were curtained off at night and each of these received electric light from a 100 watt bulb. In the planting of August 21 there was an increase of 100 per cent in the number of spikes produced in the artificially lighted plots compared with the non-illuminated plots. In the planting of September 11 fewer spikes were produced in the lighted plots than in the lighted plots of August 21, but no spikes at all were produced in the plots not receiving light. Several of the spikes were in full bloom for Christmas Day. In a later experiment an effort was made to determine whether better results could be obtained from side lighting as distinguished from overhead lighting. Both 100 and 300 watt lights were used. No measurable differences were noted.

The Storage of Gladiolus Corms. (L. H. Jones). Gladiolus corms are harvested in the early autumn and placed in storage until the following spring. Forcing gladiolus in the winter has made it necessary to carry the corms in cold storage during the summer, thus prolonging the dormant period. A cold storage temperature of about 38° F. gave the best results

and usually 100 per cent germination was obtained. Experiments have shown that corms properly stored may be kept in cold storage two years, and positive blossoming results have been obtained after three winters and two summers in storage. The corms should be in shallow trays to permit free circulation of air. An experiment is now under way to determine the maximum time corms may be stored.

Influence of Light Quality on Plant Growth. (A. V. Osmun). The experiment to test the effect of Vita glass on plant growth and development has been continued with somewhat contradictory results. In one test, radishes grown under Vita glass averaged 1.7 grams or 10 per cent less in weight than those grown under ordinary glass; while in another test, the difference was 3.5 grams or 14 per cent in favor of the Vita glass. Lettuce under ordinary glass weighed 3 per cent more than that grown under Vita glass. Compared with previous tests in which radishes under Vita glass increased 71 per cent in weight and lettuce 76 per cent over the plants under ordinary glass, the results are very inconsistent. The tests will be continued.

The Effect of Decomposing Paper on Plant Growth. (L. H. Jones). Nitrogen deficiency in a plant may result from decomposing paper in a soil or from a plant container made of paper in contact with the soil mass. This has been well established by incorporating paper mulch in a soil and also with improperly water-proofed paper flower pots. When paper mulch is incorporated in a soil, nitrogen starvation may ensue unless an available form of nitrogen is supplied to the plant. Using tomato seedlings in four-inch pots with and without paper mulch in the soil, it was noted that all plants made equally good growth for one month. At the end of the second month, the plants in the soil containing no mulch were 33 per cent taller than plants in a soil with mulch, and averaged nine axillary shoots. The plants in the soil containing mulch were without axillary shoots and were more yellow in color, indicating a lack of nitrogen due to decomposing cellulose.

The problem of obtaining good plants from paper pots is not one of soil acidity nor lack of porosity. It has been demonstrated that better plants can be grown in undrained glass containers than in porous clay pots. When plants become yellow in paper pots, they can be made to resume normal growth by an application of sodium nitrate. If the fibers in the paper pot are so protected that decay is impossible, plants equal to those grown in porous clay pots may be grown in these pots.

Chlorosis of Snapdragon caused by an Excess of Lime. (L. H. Jones and H. D. Haskins). Snapdragon plants grown in a greenhouse soil made from a sandy subsoil mixed with manure and lime became very chlorotic. As the new leaves were yellow in the early stage of development the cause seemed related to a deficiency of iron in the plant. When tested for reaction, the soil was decidedly alkaline (pH 7.9). Pot work indicated that the trouble could be overcome by leaching the soil with a 1 per cent solution of sulfuric acid at the rate of one gallon per square foot. The soil so treated was leached of acid with an equal volume of water and then supplied with a complete fertilizer mixture. In the absence of the sulfuric acid treatment, fertilizer materials of superphosphate, potassium sulfate, and ammonium sulfate, either alone or together, were ineffectual. The iron of ferric chloride was not assimilable. Although snapdragons

suffered markedly from the high amount of lime, stocks were quite tolerant and did well.

The Effect of Temperature on the Nitrate Content of the Soil and Plant Growth in the Presence of Decomposing Cellulose. (L. H. Jones and James E. Fuller). One per cent of cellulose in a soil maintained at constant temperatures ranging from 7° to 35° C. definitely affected the nitrate content of the soil. The tomato, because of its upright habit, was employed as an indicator plant. If the soil is one with a high level of fertility, the plants are unaffected by the reduction in nitrates and the differences obtained in plant growth were directly the result of temperature, a marked increase in growth occurring at a temperature of 22° C. and above. However, if the soil had a low level of fertility, temperature ceased to affect plant growth and the response of the plant was dependent upon the available nitrogen. The presence of decomposing cellulose in such a soil reduced the dry weight of the plants as much as one-half to two-thirds of the weight of plants grown in a soil to which no cellulose had been added. With a soil rich in nitrogen the addition of cellulose caused a considerable depletion of nitrates at the lower temperatures, while at higher temperatures nitrification was sufficiently active to replace the nitrate used by the cellulose decomposing organisms. In a poor soil to which a considerable amount of cellulose was added the ratio of nitrate to cellulose appears to have been so small that temperature had little influence on the degree of nitrate depletion, the rate of nitrification, or the response of the indicator plant.

Temperature Control Tanks. (A. Vincent Osmun and L. H. Jones). Many changes and improvements have been made in the apparatus for maintaining constant soil temperatures. Better results are now obtained with less attention and lower maintenance cost. In conducting an experiment of three months' duration no adjustments were necessary except the replacement of a loose nut on one of the contactors. Each of the thirteen compartments maintained its temperature throughout the period. This apparatus is available for many types of research. It has been of invaluable assistance in the study of the following problems: the smut disease of onions, black root-rot and brown root-rot of tobacco, nematode galls, growth of gladiolus in the greenhouse, soil temperature in plant containers, *Verticillium* wilt of eggplant.

An Electric Steam Generator for Sterilizer Retorts. (Howard Bidwell and L. H. Jones). This steam generator was developed to fulfill the requirements of obtaining a sterilizing pressure quickly, and is a decided departure from the usual type. About 80 per cent of the water volume in the boiler is available for supplying steam to the sterilizing chamber, without danger of low water, or requiring intake of additional water during the sterilizing process. The principle on which this generator operates is original and eliminates the usual delay in obtaining the required sterilizing pressure. The generator is under automatic control at all times, thus reducing necessary attention to a minimum. The details of its construction and operation are given in a paper entitled "Packed heat from a new type electric steam generator" accepted for publication in *Industrial and Engineering Chemistry*.

THE CRANBERRY STATION

(East Wareham, Massachusetts)

H. J. Franklin in Charge

The station has enjoyed for the first time, during the most active part of the 1930 cranberry season, the effective cooperation of the extension services of Plymouth and Barnstable Counties. These counties together hired a special agent, an experienced cranberry grower of Kingston, Mass., to conduct the cranberry extension work from the middle of May till the middle of August. The work was handled satisfactorily, and more time was available for the station's research work in spite of an increase in the number of extension calls.

Injurious and Beneficial Insects Affecting the Cranberry. (H. J. Franklin). Various samples of pyrethrum soap were tested on different kinds of insects to guide manufacturers of these soaps in improving and standardizing their products. Bog tests of pyrethrum soap sprays brought out clearly that such sprays are entirely safe to use on cranberry vines whenever it is safe to spray with nicotine sulfate and soap. They are likely to cause serious loss by blasting blossoms or newly set berries or by stunting small berries if they are applied while the vines are in full bloom or before the berries are well started in growth. Pyrethrum extracts without soap, such as Evergreen, did harm to blossoms and small berry sets in some cases, but were generally much less injurious than pyrethrum soap. The season's experience with pyrethrum soap sprays leads to the conclusion that such sprays are preferable to nicotine sprays for treating the first brood of the black-headed fireworm (*Rhopobota vacciniana*), for they are fully as effective and kill much more promptly. The prompt kill is a great advantage, especially if it rains soon after the spraying is done.

Penetrol, used in sprays as directed by the manufacturer, did material injury when applied to cranberry vines during and just after the blossoming period.

Bog tests showed that it takes an application of sodium cyanide solution about sixteen hours to kill a satisfactory percentage of an infestation of the cranberry root grub (*Amphicoma vulpina* Hentz.). Tests with herring in tubs of water containing samples of treated bog soil showed that the cyanide poison used to treat this grub persists in the soil in considerable strength at least a week. In treating the soil, six ounces of the cyanide had been used to a hundred gallons of water, and the solution had been applied at the rate of a gallon to the square foot. This treatment has proved satisfactorily effective in killing these grubs in all their stages including the flaccid stage that comes just before pupation, but it seems to kill the pupae much less readily. It should therefore always be completed before the grubs begin to pupate.

Submergence tests were conducted with partly grown nymphs of the cranberry black bug (*Plagiognathus repetitus*) and of the false blossom leafhopper (*Ophiola striatula* Fallen). The insects, in tin coffee cans with muslin tied over the tops, were submerged to a depth of about a foot in Spectacle Pond at East Wareham. A complete twelve-hour submergence was not enough to kill all the nymphs of either of these two species; but

eighteen hours killed them all. It appears, therefore, that these pests can be controlled more safely by flooding in June than has heretofore been thought possible.

In cooperation with the Bureau of Plant Industry, a very satisfactory chemical color test was developed for determining roughly the oxygen content of water used in bog flooding. This test is so simple that it may be used readily by cranberry growers.

Cranberry Disease Work. (H. J. Franklin in cooperation with the Bureau of Plant Industry, U. S. D. A.). Forecasts of the very poor keeping quality of the fruit of the 1930 cranberry crop were made by the station. They were based on weather records and incubator tests and proved to be timely and accurate.

Weather Observations. (H. J. Franklin). Local weather observations were made and reported to the office of the Weather Bureau at Boston, and further records bearing on frost forecasting were gathered from various special stations as in previous years.

Forecasts of minimum bog temperatures were made in the frost seasons in the early afternoon and early evening and distributed by telephone as heretofore. Frost conditions were so accurately determined that flooding for frost protection was not once begun unnecessarily at the station bog, and three of the four times that such flooding was done there the water was started on in the middle of the afternoon. No one ever remained at the station to watch conditions after the early evening observations were made, and the amount of injury to the bog from frost was negligible.

Southeastern Massachusetts, in common with much of the rest of the country, had the worst drought during July that it has experienced in a great many years. Advantage was taken of this to gain information about the effects of drought on cranberry fruiting. For this purpose plots were laid off on Early Black and Howes sections on the station bog and were watered with about two inches of water once a week during the drought period. The water was put on with a hose, the open end of which was pushed in among the vines at intervals so as to wet the soil well without wetting the vines. The berries from these plots and from unwatered checks near them were picked on the following dates: Early Black variety on September 6; Howes variety on September 18. The berries from the watered areas were notably larger in all cases than were those from the checks, as shown by the following average cup counts (the inspectors' cup of the New England Cranberry Sales Co. being used):

Variety	Cup Counts	
	Watered Areas	Checks
Early Black	114	140
Howes	145	165

The average quantity of fruit per unit of area was 50 per cent greater by weight and 55 per cent greater by volume from the watered areas than from their checks. The berries from the watered areas had a much better color than those from the checks and were evidently fully ten days ahead in ripening.

Varieties. (H. J. Franklin). The study of cranberry varieties, their

characteristics and correlations received more attention during the year than any other one line of investigation. It was found that the most desirable varieties, as measured by productiveness and disease resistance, seldom or never develop berries with more than four locules, while berries with five or six locules are not uncommon among the fruit of many inferior varieties. As a result of these studies with cranberry varieties, the following conclusions have been reached:

(1) *Disease resistance is a unit.* In other words, varieties that resist one disease notably tend to resist other diseases well.

(2) *Disease resistance is an intimate co-function with productiveness.*

(3). *The significance of the important correlations bearing on productiveness and disease resistance apparently may be expressed by the following formula:*

$$P+R+M=T-W$$

In this formula, P is productiveness as measured by the number (not the quantity) of berries produced to a unit of area, R is the amount of disease resistance, M is the minimum of plant structure necessary for the fruit production, T is the total result of the constructive work done by the vital activities of the plants, and W is the total of the varietal wastes. The following are the leading wastes so far noted and determined:

(a) *Seeds.* Only a few small seeds are necessary. The more numerous and the larger the seeds, the more they tax the plant economy needlessly.

(b) *Wax.* A bloom on the fruit is not essential, and its development seems to be very costly to the vines.

(c) *Sugar.* Much sugar in the berries is not essential.

(d) *Pectin.* This has not been studied much yet, but it is likely to be one of the wastes.

(e) *Excessive vine growth,* as indicated by coarseness of the vines or tallness of the uprights or both.

As M in the above formula should be practically the same for all varieties, the value of P+R necessarily varies directly with the value of T-W; and since the accumulated records and observations of the actual performance of different varieties indicates that the value of P+R is inversely and greatly dependent on the value of W, it seems probable that T varies only moderately on the average. As will be seen, when the value of T-W is low, P can have a high value only when the value of R is low and vice versa.

Through special assistance during the summer months, the photosynthesis of several of the leading varieties was studied. Hydrogen-ion determinations were made of the fruit of a large number of varieties and the pH value was found to be about 2.6 with all varieties at all times during the picking and storage season.

Cultivated Blueberries. (H. J. Franklin). Fairly extensive counts of the seeds of quite a number of cultivated blueberry varieties were made and it was found that the most desirable varieties, as measured by the quantity and size of berries produced, had notably fewer seeds than the others in nearly all cases.

DEPARTMENT OF DAIRY INDUSTRY

J. H. Frandsen in Charge

A Study of Packaged Ice Cream. (K. E. Wright). This project has been continued throughout most of the year, and the results have been tabulated and published as Bulletin 269.

The Effect of Initial Cooling Temperatures on Gelatin in the Aging of the Ice Cream Mix. (K. E. Wright). Work so far completed on this project indicates that much of the texture benefits resulting from aging an ice cream mix are associated with the viscosity imparted by gelatin, and that high initial temperature in the aging period favored the development of greater viscosity. It was also determined that the maximum viscosity was found to be imparted when the mix was allowed to cool from 80°-100° F. to 40° F. without agitation, and that the whipping property was decreased as the viscosity increased.

This work as far as completed indicates that the results of aging an ice cream mix are dependent upon the factors affecting crystallization of the gelatin portion of the product.

Factors Affecting the Aging Time of Ice Cream Mix. (K. E. Wright). Work so far completed would indicate that the solidification of fat in the aging of the mix is a minor factor and that the adsorption is probably the important factor.

Only 50 per cent of the benefits of aging in a 24-hour period are obtained during the first 4 hours, and the rate of adsorption or whip improvement appears to depend on the amount of emulsifying agent available, i.e., a butter mix improves more slowly than a cream mix or one containing egg yolk. A fairly satisfactory relation was found between the surface tension and the ease of whipping. In all cases a decrease in surface tension was noted after a 24-hour aging period. Cream mixes were found to have less surface tension than butter mixes. Buttermilk was found to have a lower surface tension than skimmilk, and the addition of buttermilk to a butter mix lowered the surface tension of the mix and improved its whipping property.

Extractions of egg yolk with various fat solvents indicated that the solvent altered the emulsifying agent. An ice cream freezer was developed which was found to be very useful for experimental freezing and is an improvement over the commercial freezer because of its smaller capacity. Chemical study of the emulsifying ingredients of ice cream mixes is being continued along with cataphoretic measurements of the effects of the ingredients which aid emulsification.

A Study of Frozen Sweet Cream for Use in Ice Cream. (M. J. Mack). This project has been active the last two years and full report is published in Bulletin 268.

The Utilization of Frozen Fruits in Ice Cream. (M. J. Mack). This study is being conducted in cooperation with the Department of Horticultural Manufactures. The third crop of such fruits as strawberries, raspberries, cherries, and peaches is now being studied. This year the fruit has been packed with cane sugar in fruit to sugar ratios of 2:1 and 3:1, with sugar syrup, with invert sugar, and in partial vacuum. Fruits preserved in these different ways are being compared in order to determine their relative merits for use in ice cream.

Use of Gelatin in Ice Cream. (W. S. Mueller). Investigation for new uses of gelatin in ice cream has resulted in developing (1) gelatin fruit cubes, (2) modified Aufait ice cream, (3) filling for ice cream pies and cubes. The same principle is employed in all these uses; namely, the addition of edible gelatin to fruit juice or to a water solution containing fruit acid. Crushed fruits may also be added. The fruit cubes are cut to $\frac{1}{4}$ inch size and scattered into the ice cream at time of drawing. Modified Aufait ice cream is made by placing layers of jellied fruit juice, with or without crushed fruit, into brick ice cream. The filling for the ice cream pies is similar to the material used in making the modified Aufait ice cream. Some difficulty has been experienced in keeping the jellied fruit juice clear, due to the low temperatures to which it must necessarily be subjected when used in ice cream. This troublesome ice crystallization has been largely overcome by using the correct amount and kind of sugar and also maintaining the correct amount of acidity. A variety of sugars; namely, cane, corn, invert and corn syrup, has been used in various combinations. Freezing point determinations are being made for various sugar-gelatin- H_2O solutions. The addition of jellied fruit juice to ice cream seems desirable from the standpoint of attractiveness which the clear, bright-colored jellied fruit juice gives to the ice cream.

A study of the effect of time and temperature in cooling an ice cream mix upon the behavior of gelatin has been made. Initial cooling temperatures ranging from $0^{\circ}C.$ to $60^{\circ}C.$ were used. An initial cooling temperature of $20^{\circ}C.$ for 4 hours gave the maximum basic viscosity, increased the gel strength, increased melting resistance and improved the texture for the particular mix used. A study is now under way to determine what factors influence the degree of results obtained when using a high initial cooling temperature. The following factors are being studied:

1. Strength of gelatin
2. Amount of gelatin
3. Amount of butterfat
4. Amount of serum solids
5. Amount of sugar
6. Source of butterfat and serum solids

A new type of colloid mill is being used experimentally in place of a homogenizer for processing ice cream mixes. The effect upon the physical properties of the mix and the desirability of the finished product are being studied.

Preliminary experimental work on the value of gelatin in retarding "sandiness" in ice cream has shown that gelatin has a greater value in this respect than is generally conceded.

A number of commercial stabilizers are being used with gelatin in ice cream. Preliminary experiments have shown a mutual precipitation of gelatin with some of the stabilizers and no mutual precipitation with others. Experiments are now being planned to determine the cause for this mutual precipitation.

The Comparative Efficiency of Electrically-operated Tanks Versus Ice in the Cooling of Milk. (J. H. Frandsen). Whether the tank is of home construction or specially manufactured, it is essential that it be of ample capacity; roughly speaking, when filled with cans to full capacity there should still be room for twice as much water and ice as milk. If the tank

is of home construction, there should be at least 3 or 4 inches of cork or its equivalent and this of course must be protected against moisture. Such insulation saves more than its cost in saved refrigeration in one season. Electric cooling of milk is entirely practicable. The machines tested are convenient, reliable, and, if well adjusted, economical, although the probable service cost and annual depreciation charge were not determined. Electric milk cooling tanks are a distinct labor-saving device and are more sanitary than natural ice.

DEPARTMENT OF ENTOMOLOGY

A. I. Bourne in Charge

Investigation of Materials Which Promise Value in Insect Control. (A. I. Bourne). Further studies were made of the different types of oil sprays with special reference to European red mite control. Red mite infestation was comparatively light throughout all the college orchards. Under such circumstances all the oils gave satisfactory control with but slight distinctions between types.

Quad and triplex nozzles proved to be as satisfactory as spray guns and superior to old-type rod and nozzles. They were superior to guns in maintaining a mistlike spray enveloping the trees, and coverage was practically as rapid. Guns were superior under unfavorable wind conditions.

Weather conditions were favorable during the delayed dormant period. The temperature was somewhat above normal, but not excessively so as in 1929. No injury was noted following any oil spray used.

Of the miscible oils, Sunoco, Scalecide and Dendrol showed their customary high efficiency; well over 95 per cent control. Of the emulsions, Kleenup at 4 gallons to 100 gave 95 per cent control, somewhat better than results in 1929.

Tests of miscible oils combined with commercial copper fungicides and of soapless emulsions with lime-sulfur showed no injury to the trees or lessened insecticidal efficiency of the oils.

Comprehensive tests of relative coverage of different oil sprays and of lime-sulfur, in a block of 15-year-old apples selected because of the uniformity of size and spread of the trees, indicated a considerable superiority of the oils over lime-sulfur in material and time necessary to spray the same number of trees. The differences between the various types of oil sprays were comparatively small, and would not point to appreciable superiority of any one type over another when considered on a commercial basis.

In cooperation with The Pomology Department, tests were made with some of the materials or combinations of materials designed to replace lead arsenate as a stomach poison or to furnish a fungicidal action equal to lime-sulfur and at the same time avoid the toxic effects of the lead arsenate-lime-sulfur combination upon fruit and foliage.

Calcium arsenate in combination with aluminum sulfate and lime-sulfur, with lime-sulfur alone and with the addition of excess lime was used in a block of five varieties of apples which included four of the so-called "New England Seven", namely Baldwin, Northern Spy, R. I. Greening and McIntosh. These sprays were compared with the standard lead arsenate-lime-

sulfur combination used with and without the addition of a casein spreader. The schedule which was followed consisted of a pre-blossom and a calyx spray, two cover sprays, and an apple maggot spray in July.

The aluminum sulfate-calcium arsenate-lime-sulfur combination showed excellent persistence and caused neither injury to foliage nor russetting of fruit.

Calcium arsenate and lime-sulfur showed good adhesive qualities but caused considerable burn to foliage of McIntosh and serious burn on other varieties. With the addition of excess lime burn was not so severe but was present on all varieties including McIntosh. Both sprays caused a considerable drop of leaves during June and July, although to a less degree when excess lime was added.

Slight burn was noted following the lead arsenate-lime-sulfur combination both with and without casein spreader. The varieties showed considerable difference in susceptibility to burn. Injury was most pronounced on foliage of Baldwin and King; least so on McIntosh.

Flotation sulfur and calcium sulfide, two new materials designed to replace lime-sulfur as fungicides, were used in combination with lead arsenate to test their compatability with that material. These were used in blocks of McIntosh, a variety subject to scab, and Baldwin, which is very susceptible to spray burn and russetting. Neither of these materials caused injury to foliage or russetting of fruit on either variety, and both showed good coverage and excellent persistence throughout the season.

The comparative value of these sprays is shown in the following table, based on examination of the McIntosh crop at harvest.

McIntosh Apples, Block A

Treatment	PERCENTAGE OF FRUIT SHOWING	
	Scab	Insect Injury
Calcium arsenate	0	37
Aluminum sulfate		
Lime-sulfur		
Calcium arsenate	2	20
Lime-sulfur		
Calcium arsenate	2	28
Lime-sulfur		
Excess lime		
Lead arsenate	0	20
Lime-sulfur		
Lead arsenate	2	14
Lime-sulfur		
Spreader		
Check.....	54	58

McIntosh Apples, Block E

Flotation sulfur	0.2	11
Lead arsenate		
Calcium sulfide	4	8
Lead arsenate		
Lead arsenate	4	20
Lime-sulfur		
Check.....	55	49

All of the sprays showed excellent control of scab as compared with unsprayed checks. Combinations containing calcium arsenate controlled scab as well as did those containing lead arsenate, but were slightly less efficient against insect pests. Flotation sulfur and calcium sulfide combined with lead arsenate controlled scab as well as or better than the lead arsenate—lime-sulfur spray and showed somewhat better control of insect pests. The record on Baldwins showed similar results except that scab was practically absent in all the sprayed plots.

Control of Onion Thrips. (A. I. Bourne). The dry, hot weather early in the season interfered somewhat with the growth of both set and seed onions and threatened an early and heavy infestation of thrips. Subsequent rains during June and July allowed the plants to make rapid recovery and tended to retard the development of the insects. As a result, thrips were but moderately abundant and caused less injury than in 1929 except in some fields of seed onions adjoining sets.

The seasonal development and activity of thrips were normal and occurred at the usual periods. This insect did not reflect the tendency of the season to be somewhat earlier than usual, which was very noticeable in many crops as well as insects.

Observations, through the growing season, of a field of seed onions at a distance from sets showed the infestation of thrips to be negligible up to July 7, from July 21 to 28 it averaged 25 to 40 thrips per plant, and reached its peak during the week of July 28 to August 4 with an average of 40 to 42 thrips per plant. This coincided very nearly with the point where the plants had reached maximum height. Beyond this point the numbers of thrips fell rapidly. In this field the plants showed little scarring and matured a good crop.

In contrast to this, a field similar to the above but subject to infestation from an adjoining field of set onions was found to be infested early in the season, and by July 7 the number of thrips had reached an average of 35 per plant. By July 14 noticeable injury was taking place. The peak of abundance was reached on July 28 with an average of more than 80 thrips per plant. Plants in this field were not making satisfactory growth and were badly scarred by the insects. Two applications of the nicotine-soap spray reduced the average infestation from 80 to 10. These plants revived somewhat and made new growth but matured a small and rather inferior crop.

Several species of insects predacious on thrips were collected in onion fields. Their numbers were insufficient, however, to make any significant impression upon the infestation.

Four applications of nicotine soap spray were necessary to protect seed onions growing alongside fields of sets. Due to the transference of thrips in large numbers from the sets and consequent early colonization of the small, tender plants of seed onions, two of these applications were made earlier than would be necessary on fields not so exposed.

In connection with the study on blast in cooperation with the Botany Department, spraying and dusting experiments were conducted with Bordeaux mixture, commercial copper fungicides and with milk of lime, alone and in combination with nicotine. The weather conditions prevailing during the summer were unfavorable for the development of blast. Mildew was also absent. In the absence of disease, no appreciable increase or de-

crease in yield resulted from dusting. Yields were increased somewhat by applications of Bordeaux sprays. Onion fields in the Valley were observed at frequent intervals during the growing season to note the appearance and extent of disease and insect pests. No instance of blast or mildew was discovered. Dry weather and a moderate infestation of thrips were the chief factors affecting the crop.

Control of the Plum Curculio in Apples. (W. D. Whitcomb, Waltham). Although fruit growers secured better control of the plum curculio in 1930 than in recent seasons, this appeared due to cumulative benefits from improved control measures and timely spray applications rather than to a noticeable increase in natural mortality. The infestation, determined by the number of larvae emerging from one bushel of unsprayed dropped apples in 1930 was 3047, compared with 3137 in 1929, and 2379 in 1928.

Preliminary studies of the effect of temperature on the activity of the plum curculio showed that beetles confined at temperatures above 70° F. made three times as many punctures (1991) as those held below 70° F. (629). The corresponding number of punctures at normal outdoor temperatures was midway between the two extremes (1191).

The effect of maximum daily temperatures on curculio activity as determined from insectary records of the past four years is variable yet shows an average increase of 12 to 27 punctures per day for each 10° rise in temperature.

Beetles feeding on well-sprayed fruit of normal size at the time of the calyx spray lived 10.6 days, and when supplied with normal fruit one week later they lived 10.3 days. With sprayed fruit gathered two weeks and three weeks after the petal-fall period for food, the beetles died in 4.9 days and 3 days respectively.

In both laboratory and field experiments, barium fluosilicate and synthetic cryolite failed to control the plum curculio as well as equal amounts of lead arsenate. Chemical hydrated lime added to the lead arsenate-lime-sulfur combination spray was also less effective than the standard solution. Molasses, fish oil, or linseed oil used as a sticker with lead arsenate was more effective than flour paste or calcium caseinate. An 85-15 sulfur-lead arsenate dust was very effective in the laboratory, but barium fluosilicate-lime, cryolite-lime and naphthalene-lime dusts failed to kill the beetles.

The Spray Residue Problem. (A. I. Bourne). Another season of light rainfall again emphasized the necessity of careful arrangement of the spray schedule in order to avoid arsenical residue on fruit at harvest, in excess of the established limit of tolerance. Rainfall was considerably below normal, although the deficiency was not as great as in 1929. The fact that the greatest shortage was in late July and August was of considerable significance, since it followed the sprays applied in late July for apple maggot and codling moth control, increasing the risk of residue from those applications.

Attention was centered chiefly upon commercial orchards where the schedule included one or two July applications of spray, and on those which were dusted once or more in August. Cooperative tests of different dust materials were made in one commercial orchard.

Analysis of fruit from these orchards shows that in a season such as

1930, Wealthy and similar varieties should not be sprayed later than about July 10. If further protection is necessary, dusts should be used. McIntosh sprayed as late as the third week of July showed a sufficient margin of safety unless heavy, drenching applications were made. Baldwins could be sprayed through July with safety. In all cases where sprays are applied after July 15, any spreading or sticking agent should be omitted and lighter strength of lead arsenate should be used.

Results showed that dusts, if properly applied to McIntosh or Baldwin, could be used as late as August 15 without encountering any difficulty.

The Biology and Control of the Carrot Rust Fly. (W. D. Whitcomb, Waltham). The average over-wintering population of the carrot rust fly at Waltham in 1930 was 39 pupae per square foot where infested carrots remained in the soil, compared with 79 per square foot in 1929, and this should have produced a normal moderate infestation in early carrots. However, the injury by the first generation was negligible, apparently due to the dry, hot weather during the oviposition period in early June. Under laboratory conditions twenty eggs kept in the greenhouse at temperatures always above 70° failed to hatch, while a similar number of eggs in a root cellar maintained at 60°-70° F. hatched perfectly in twelve and thirteen days.

The normal second generation infestation was consequently very light, but a moderate amount of injury was caused in October by a combination of third generation and late second generation maggots. Flies emerged as late as November 10.

Carrots planted May 1 or later were free from injury by the first generation, and the variety plantings showed no definite degree of immunity because of the general light infestation.

Early carrots were very free from injury when grown with or without paper mulch, but those under paper were 20 per cent heavier.

The results of the insecticide treatments in the field were inconclusive because of the light infestation. Carrots grown from seed treated with calomel showed considerable mercury russetting.

Derris dust, both pure and diluted 1-2 with gypsum, was very effective in killing the adult flies, and prevented oviposition, while eight other materials were much less effective, in the laboratory.

All larvae in infested harvested carrots were killed by fumigation with paradichlorobenzene and carbon disulfide. The carbon disulfide used at the rate of 4 ounces for each 100 cubic feet for eighteen hours was the better treatment.

Systematic Study of Oil Sprays. (A. I. Bourne in cooperation with the Department of Chemistry). During the winter, laboratory tests were made of the stability of samples of oil sprays prepared by the Chemistry Department, to determine the relative value of different emulsifying agents as well as of various proportions of oil and emulsifier.

Three samples of oil sprays were submitted for preliminary orchard tests. These consisted of a miscible oil (83½ per cent oil), and two types of oil emulsions (66 per cent oil). Two of these gave promising results and indicated the direction for further development of the work.

Apple Maggot Control. (A. I. Bourne). The serious nature of this pest, its abundance in recent years, and the threatened loss of foreign

markets for Massachusetts apples led to a study of different control measures and any adaptations necessary for Massachusetts conditions. The work was done in cooperation with the Extension Service and in conjunction with the county agents.

The twelve orchards chosen for the tests represented, in their size, type, location, etc., a very fair cross section of the fruit growing industry of the State, and in every case maggot had caused serious loss to the crop of the previous season.

The program called for—

(1) Regular and thorough collection of premature drops during the period of maggot infestation, and prompt disposal of such infested fruit.

(2) Treatment, either by spraying or removal, of neglected trees or orchards within 200 yards of the test blocks. In many cases this involved arrangements with neighboring owners, sometimes difficult to accomplish.

(3) Thorough spray or dust program to protect fruit and foliage during the period of activity of the adult flies.

In determining results McIntosh was the variety checked, since this was common to all the orchards. In the ten orchards where the program was carried out in full, maggot infestation in fruit scored was less than 1 per cent. Records of infestation in some of these orchards in 1929 showed the following comparison:

Orchard No.	Percentage of Maggot Infestation	
	1929	1930
1	25	0
2	90	.8
3	26 (Baldwins 40)	.3
4	Destroyed practically entire crop because of maggot infestation	.1

Supplementary observations on other varieties supported the results noted on McIntosh. The Cortlands in one orchard in 1929 were so badly riddled by maggot that the grower trucked the entire crop to the cider mill. In 1930 this variety showed but 2 per cent infestation.

Orchard surveys conducted by state and county agencies showed that apple maggot was present in considerable abundance throughout the State in 1930. In one instance an infestation of 78 per cent was noted, and in several orchards fruit showed 30-40 per cent damage. In very many cases an infestation of 10-15 per cent was noted. The results secured in the test orchards, therefore, would not appear to be attributable to any scarcity of the pest this past season.

In addition to checking apple maggot, the spray program in the test orchards enabled the growers to control many other pests and made it possible for them to harvest better quality fruit. Five of the ten growers produced McIntosh, 90-95 per cent of which was free from insect or disease blemishes. In three other orchards the fruit scored 80-85 per cent clean. The improvement made by these growers in the quality of the fruit produced is indicated by the following examples:

Orchard No.	Percentage of Crop Clean	
	1929	1930
1	1.6	51
2	10	83
3	40	82
4	Less than 10	95

One of the most encouraging features of the campaign was the fact that the late sprays or dusts recommended for control of the apple maggot gave such excellent protection against other pests as well that their use was justified aside from the question of maggot control.

DEPARTMENT OF FARM MANAGEMENT

J. A. Foord in Charge

Enterprise Relationships and Farm Organization on Selected Dairy Farms in Western Massachusetts. (R. L. Mighell). The work on this project has been somewhat more specialized than last year. Simple financial records have been continued by the owners of the farms used in the project. A more detailed study of several of the farms, based on the records already obtained, has been made by the investigator and some suggested changes in organization have been adopted. Time studies of several farm operations have already been made and more are in progress.

Types of Farming in Vegetable Garden Areas. (F. H. Branch and R. L. Mighell). This project was begun as a part of the extension work of the department, but owing to the demand for information, it seemed wise to make it one of the major projects for investigation. The Extension Service contributed funds for obtaining the data in the field; and the work was done during the summer. More than a hundred growers in the counties of Bristol, Essex and Middlesex were visited, and 320 enterprise records obtained. The tabulation and study of this material revealed important differences and several special types of organization.

The material will be available for Extension Service use this winter and also serve as a basis for investigations in these areas in the future.

Live Stock Management, Methods and Costs. (J. A. Foord). Data are being accumulated on the methods and expense of eliminating Bangs Disease in herds, as well as the advantages and labor involved in different methods of housing and handling dairy cattle.

FEED CONTROL SERVICE

Philip H. Smith in Charge

The Feed Control Service comprises not only feed inspection, but several other activities, as listed below:

- Feed Control (General Laws, 1920, Chapter 94)
- Seed Control (General Laws, 1927, Chapter 94)
- Dairy Law (General Laws, 1920, Chapter 94)
- Advanced Registry Testing
- Miscellaneous Work

Feed Control. (P. H. Smith, H. R. DeRose, A. F. Spelman, G. J. Larsinos, J. B. Zielinski, Jr.¹, J. W. Kuzmeski², F. A. McLaughlin, J. T. Howard). During the fiscal year, 1,738 samples of feeding stuffs officially collected were examined in the control laboratories. The results show that at least 96 per cent of the samples collected varied less than one per cent from stated guarantees in protein, fat and fiber content. The gross receipts from the registration of feeding stuffs in 1930 (calendar year) were \$21,000, derived from 1,050 brands at \$20 each.

Seed Control. (P. H. Smith, F. A. McLaughlin, O. W. Kelly³, Elizabeth F. Hopkins⁴, Margaret E. Nagle). From October 1, 1929, to October 1, 1930, the seed laboratory analyzed 854 seed samples, 349 of which were collected by the State Commissioner of Agriculture, 390 sent in by dealers and farmers, and 115 from the Rhode Island State Commissioner of Agriculture. Classification of these analyses is shown by the following summary.

Summary of Samples Analyzed

	Rhode Island	Non-Official	Official	Total
Purity only	20	18	18	56
Germination only	4	235	216	455
Purity and Germination	91	137	115	343
				854
Field Crops	7	120	18	145
Forage	104	103	115	322
Vegetables	4	158	216	378
Tree		9		9
				854

Field tests to determine trueness to type were again conducted in cooperation with the Department of Agronomy which tested 16 samples of red clover, 4 of sweet clover and 11 of alfalfa, and the Department of Vegetable Gardening which tested 132 varieties and strains of varieties of onions.

Dairy Law. (P. H. Smith, J. T. Howard, H. L. Allen). During the year ending December 1, 1930, 8,871 pieces of Babcock glassware were tested, an increase of 356 over 1929. Condemned glassware consisted of 13 milk pipettes, which were not condemned on account of inaccuracy of graduation but because they did not meet with accepted standards; the graduation mark was so near the suction end of the pipette as to render pipetting difficult. Ninety-four certificates of proficiency were awarded.

¹ Resigned Oct. 1, 1930.

² Resigned Jan. 1, 1930.

³ Resigned June 1, 1930.

⁴ Temporary appointment for month of July.

One hundred and sixty creameries, milk depots and milk inspectors' laboratories were visited in order to check methods and pass upon equipment in use. As a result of this inspection, three machines were condemned outright, major repairs were ordered on five, and minor on twelve. In eighteen places new glassware was ordered, and at four, operators were cautioned on account of improperly cleaned glassware. Twenty-seven places were ordered to keep composite samples in better condition. Where it is thought necessary, re-inspections will be made. At the request of interested individuals, special investigations were also made at four different plants.

Advanced Registry Testing. (P. H. Smith). Advanced registry testing has been supervised by this department since its beginning in 1902. This work has been carried on for so long that there is no material growth in it from year to year. The work at this time (November 1929) is of practically the same volume as it was a year earlier. There are now on yearly test 602 cows located on 77 different farms. This does not include the herd tests where all animals in each herd are placed on test. Of these there are eighteen, six of which are supervised by men sent out from this office and twelve by cow-test association supervisors.

Miscellaneous Work. (P. H. Smith, J. W. Kuzmeski, J. B. Zielinski, Jr., A. F. Spelman, G. J. Larsinos). Numerous analyses have been made for residents of the State and other departments of the College. Especial attention is called to the increasing number of dry matter determinations in connection with forage crop experiments. This work has become a real burden upon other work of the department and should it increase materially, the employment of an additional assistant during the summer months will be necessary.

Summary of Miscellaneous Work, 1930

Materials sent in:

Milk and cream, butterfat only	388
Milk, solids and fat	28
Feeds	66

For other departments of Experiment Station and College:

Milk, for butterfat	200
Dry matter, forage crops	1,324
Complete fodder analyses	177
Dry matter and nitrogen	127

FERTILIZER CONTROL SERVICE

H. D. Haskins in Charge

Fertilizer Inspection. (H. D. Haskins, H. R. DeRose, A. F. Spelman, J. B. Zielinski, Jr., and G. J. Larsinos). During the season, 135 firms or individuals have registered for sale in Massachusetts 598 brands of mixed fertilizers and unmixed fertilizing materials and 26 brands of agricultural lime and gypsum. The nature of these materials, as well as statistics with reference to the inspection, is given in the following summary.

Products	Brands Regis- tered	Brands Col- lected	Samples Col- lected	Number of Analyses	Number of Determina- tions*
Mixed fertilizers	361	338	1153	394	5122
Ground bone, tankage and fish.....	59	51	134	60	316
Nitrogen products, organic and mineral	76	64	240	149	330
Phosphoric acid products.....	30	28	100	31	155
Potash products	34	30	69	39	149
Dried, pulverized natural manures.....	21	21	80	23	115
Miscellaneous	10	8	16	14	71
Lime products	26	26	41	29	145
Nitrate of potash.....	6	5	11	7	28
Ammonium phosphate	2	2	5	4	24
Totals	625	573	1849	750	6455

* Not counting check tests or repeats, which would probably amount to one-third more in number.

The four men employed to secure samples for the year's inspection sampled 19,631 sacks or containers, representing 5,875 tons of material; 912 agents were visited.

From July 1, 1929, to July 1, 1930, the tonnage of fertilizer and plant food sold in Massachusetts was as follows:

	Fertilizer (Tons)	Plant Food Nitrogen	Elements Available Phosphoric Acid	(Tons) Potash
Mixed fertilizers	42,881	1,791	3,366	2,703
Unmixed fertilizer chemicals and materials	21,249	1,441	1,636	584
Pulverized natural manures	2,491	56	37	77
Totals	66,621	3,294	5,039	3,364

Full details of the fertilizer and lime inspection will be found in Bulletins 54 and 57, Control Series.

Miscellaneous Analytical Work. (H. D. Haskins, H. R. DeRose, J. B. Zielinski, Jr., and G. J. Larsinos). As usual, the last two months of the year and the first three months of the new year, much cooperative chemical work was carried on with other departments of the Experiment Station. The general nature and extent of this work may be seen from the following summary:

Cured tobacco, complete ash analysis	16
Complete fertilizer	1
Dwarf Essex rape plants, dry matter and phosphoric acid	81
Fertilizer chemicals and unmixed materials	3
Japanese millet plants, dry matter and nitrogen	101
Onions, partial ash analysis	1
Organic ammoniates, complete analysis including nitrogen activity	25
Phosphates, complete analysis for vegetation test	18
Soil analysis, partial chemical	29
Soil mechanical analysis	7
Tobacco plants, partial analysis	21

The fertilizer department has also been active in assisting the citizens of the State, through farm organizations, institutional departments, and in

personal contact with the individual, in the analysis of a variety of materials of interest to agriculture. Where the results of the work are of principal interest to the individual a nominal charge has been made as in the past. Interpretations and advice accompany the report of analysis in all cases. The following materials have been analyzed under this heading:

Complete fertilizers	11
Fertilizer chemicals and unmixed materials	73
Fish, tankage and bone	5
Lime products	1
Insecticides	1
Manures	3
Manufacturers' by-products, for fertilizer value	3
Miscellaneous	2
Peat products	15
Soils, complete chemical analysis	7
Soils, partial chemical analysis	12
Soils, mechanical analysis	10
Wood and cotton hull ashes	14

In addition, the usual amount of cooperative work has been done for the Association of Official Agricultural Chemists, consisting of analytical work for the Referee on Nitrogen, and service on the Committee on Definition of Terms and Interpretation of Results on Fertilizers and Lime Products.

Vegetation Pot Experiments. (H. D. Haskins, G. J. Larsinos and H. R. DeRose). An experiment comprising 79 pots in a study of phosphoric acid availability of 18 phosphates was begun. It is hoped that the experiment may be continued for two years more before final conclusions are drawn. A vegetation experiment was also conducted in further study of the nitrogen availability of processed low-grade organic substances, oil-extracted seed residues and other organic nitrogenous materials which are largely used in mixed commercial fertilizers. Pots were also included to note the effect of manganese sulfate. Detailed results of these experiments are reported in Control Bulletin 54.

DEPARTMENT OF FLORICULTURE

Clark L. Thayer in Charge

Study of the Effect of Plant Nutrients on Carnations and Roses Under Glass. (H. E. White, Waltham). This project was started in June, 1930, with the aim of studying the effect of the sources of nitrogen and phosphorus (organic and inorganic) on growth and flower production. Fifteen plots of thirty-five plants each of carnations, triplicated, and fifteen plots of twenty-four plants each of roses, duplicated, were established; fifteen fertilizer treatments are being used.

Since the first heavy crop of carnations is just coming into bloom, it is not possible to present data on flower production. The plots receiving the following treatments have produced taller and heavier plants:—manure and superphosphate, manure and peat, superphosphate and peat. There

does not appear to be any visible difference between the remaining plots.

The rose plots which received manure and peat, superphosphate and peat, and manure and superphosphate have produced stronger plants and have given a few more blooms per plant during the month of November.

Definite conclusions cannot yet be drawn from the experiments, since the work has been in progress for a comparatively short time.

The following table shows the various plot treatments.

Plot No.	Treatment	Plot No.	Treatment
1	Superphosphate Manure	9	Nitrate of Soda Bone Muriate of Potash
2	Manure Peat	10	Urea Superphosphate Muriate of Potash
3	Superphosphate Peat	11	Calurea Superphosphate Muriate of Potash
4	Nitrate of Soda Superphosphate Muriate of Potash	12	Blood Superphosphate Muriate of Potash
5	Nitrate of Soda Superphosphate Muriate of Potash	13	Nitrate of Soda Basic Slag Muriate of Potash
6	Guano Superphosphate Muriate of Potash	14	Nitrate of Soda Superphosphate Muriate of Potash
7	Fish Superphosphate Muriate of Potash	15	Nitrate of Soda Basic Slag Muriate of Potash Swamp Peat 2:1
8	Fish Bone Muriate of Potash		

Breeding Snapdragons for Varietal Improvement and Disease Resistance. (H. E. White, Waltham). The work on the development of rust-resistant varieties of snapdragons for commercial use was started in June, 1930. Twelve rust-resistant strains, obtained from the Purdue University Agricultural Experiment Station, were planted in the field among ten garden varieties. By August 12 the garden varieties were destroyed by rust, whereas seven of the twelve resistant strains produced thirty plants that were entirely free from the disease. Since these strains do not possess flower color and length of stem desirable in commercial varieties, it will be necessary to breed plants having the desired commercial qualities and the rust-resistant characters. Breeding work was not done in the field due to the hot, dry weather conditions at the time the plants were in bloom. The resistant strains are now being grown in the greenhouse and will be crossed with commercial varieties during the winter and spring.

DEPARTMENT OF HOME ECONOMICS RESEARCH

Esther Davies in Charge

Present Practices of Massachusetts Elementary Schools with Regard to School Feeding and Transportation and Their Effects upon Health of Pupils. (E. Davies). The section of this project dealing with food service has been entirely completed and a bulletin published describing the

methods used in the study and the results obtained. (Bulletin No. 263; April, 1930).

The field work for the study of transportation of pupils to rural elementary schools has been finished and the data are in process of tabulation. The study includes consideration of methods of awarding transportation contracts, requirements as to type and condition of vehicles, behavior of drivers, planning of routes, length of time transported pupils are away from home, and the relation of transportation to school absences and various pupil illnesses. In most of the rural Massachusetts towns, the entire problem of transportation is settled on the basis of financial economy, the other factors being unregarded; while the experience of a few towns shows that transportation can, if sufficient thought is given to the matter, be so arranged that the health of the pupils is not adversely affected and, at the same time, costs be kept within reasonable bounds.

The Comparative Values of Milk and Tomato as Supplementary Feeding in a Rural Elementary School. (E. Davies and M. V. E. Voorneveld). After one year of experimental feeding in a rural school in the eastern part of the State, the study is being continued for a second year in a consolidated school of similar size and racial composition, in the Berkshires. The data cannot be tabulated until the end of the second year of experimentation, and it is not now possible to reach any conclusions as to the comparative value of the food stuffs studied.

The Value of Evaporated Milk for School Food Service. (E. Davies and O. A. Merriam). This project is similar in purpose and method to that concerned with fresh milk and tomato as materials for supplementary food service in schools. The experimental work is to continue for two years, and is being carried on in a village having a very large proportion of children of foreign-born parentage enrolled in the schools. No information regarding the outcome of the experimental work is available at the present time.

DEPARTMENT OF HORTICULTURAL MANUFACTURES

W. W. Chenoweth in Charge

Extraction of Fruit Juices by Heat. (C. R. Fellers). This project has now been completed and the results are being prepared for publication. Optimum extraction methods for jelly manufacture are outlined. A new rapid centrifugal method for the determination of pectin in fruit juices has been developed which is sufficiently accurate for ordinary work.

Concentrated pectin extracts made from cull apples or thinnings, are readily prepared, inexpensive, and, when freshly prepared, suitable for use in jelly making. However, after a few months' storage precipitation occurs, and the pectin loses much of its jellifying properties. Homemade pectin extracts should, therefore, be used while fresh.

A number of commercial benzoate cider preservatives were examined for suitability for use in freshly prepared cider and grape juice. Great differences were noted. In general, too much benzoate is added to cider, from .05-.06 per cent being sufficient if the cider is fresh and reasonably free from sediment. The sharp taste of benzoated cider is due largely to chlorine impurities in the preservative.

Several types of equipment designed to determine the jelly strength of jellies have been compared. Work is being done on the development of a new jelly tester similar in construction to the Magness fruit pressure tester.

Manufacture and Preservation of Cranberry Products. (C. R. Fellers, J. A. Clague, and W. W. Chenoweth). Close cooperation with the American Cranberry Exchange and the commercial cranberry preservers has been maintained. The use of the Abbé refractometer for determining the proper finishing point in cranberry sauce manufacture has been introduced into all of the commercial canneries. By this means the quality of the sauce is maintained and every batch can be standardized to a definite sugar content (42-44 per cent), insuring also maximum yields consistent with optimum jelly strength.

Frozen cranberries held at 10° F. for 1 to 12 months were found to be very satisfactory for sauce manufacture, the sauce retaining all the flavor, color and jelly strength of the fresh-fruit sauce. This year some of the canners are freezing several thousand barrels for manufacture during the off season.

Canned cranberry sauce was shown to be impaired by freezing. The jelly strength was decreased as much as 20 per cent and syneresis (bleeding) was greatly increased.

Researches are under way in cooperation with the State Cranberry Station on the suitability of about 30 commercial varieties for canning purposes. Strained and whole sauce is manufactured from each variety, the yield, characteristics and keeping qualities being noted.

The American Cranberry Exchange of New York, through a grant of \$1000, requested the department to carry on nutritional studies on the cranberry. The first research attempted was a determination of the vitamin C content of raw cranberries and fresh and canned cranberry sauce. Preliminary results on 45 guinea pigs indicate that the raw cranberries contain substantial amounts of vitamin C, but practically all is destroyed by the manufacturing process. This work is being actively continued in order to evolve, if possible, a method of sauce manufacture which will protect the vitamin C. Cranberry juice is also a rich source of vitamin C, as little as 3 cc. per day protecting guinea pigs against scurvy for at least 90 days. The use of cranberry juice as a beverage is also being investigated.

Utilization of Onions by Canning. (C. R. Fellers). The examination of experimental packs of canned onions made in 1929 and 1930 fully bear out earlier conclusions as to the feasibility of canning onions in tin cans or glass jars. Chemical studies on canned onion discoloration are being conducted by the Chemistry Department. Continued tests on dehydrated cull onions and the ease of manufacture of onion powder or "flavor" have renewed confidence in the feasibility of utilizing cull onions in this way. Preliminary experiments on preserving small onions in brine for pickling purposes indicate that a 60 degree salometer brine is preferable to lighter brines.

Nitrogen Distribution of the Edible Portion of the Onion. (F. P. Griffiths). This project was discontinued upon the resignation of Mr. Griffiths on July 1, 1930. Nitrogen in the form of ammonia, nitrate, amino acids and protein was determined in fresh and dried onions.

Utilization of Frozen Fruits in Ice Cream. (C. R. Fellers and M. J. Mack, Dairy Department). This cooperative project has been continued for the third year, utilizing various varieties of strawberries, raspberries, cherries and peaches. For the first time fruits were packed with different syrup concentrations in place of solid sugar. Results to date indicate marked superiority of the sugar syrup packs of fruit. Oxidation, discoloration and mushiness are largely obviated by the use of 40 to 60 per cent sugar syrups. Invert syrup gave no better results than sucrose syrup. Corn sugar was distinctly unsatisfactory. Berries and cherries were frozen with solid sugar and with syrup in gallon cans under vacuum. These packs, though more costly to put up, gave the best quality of fruit. Hawaiian pineapples were superior to Porto Rican varieties for ice cream making. Preliminary work was done during the summer on freezing various vegetables.

Pasteurization of Dried Fruits. (C. R. Fellers and J. A. Clague). Further results have definitely proved that such dried fruits as dates, figs, and raisins may be effectively pasteurized and freed from insects and pathogenic bacteria by a heat treatment under standardized time-temperature-humidity relationships. This work has now been discontinued, the results being published in *American Journal of Public Health* Vol. 20, 175-181 (Feb. 1930) and *Journal of Bacteriology* Vol. 21, No. 1 (Jan. 1931).

Chemical Composition of Dates. (M. M. Cleveland). The Hills Brothers Company Research Fellow for 1931-32 is making a study of the organic and mineral constituents of dates, with special reference to nutritive properties. Possible uses for cull dates and date syrup are also included in this project.

Preservation of Rodent Bait. (In cooperation with U. S. Bureau of Biological Survey). Experiments have been conducted on the feasibility of preserving rodent baits containing red squill. If the canned product proves satisfactory, the use of poisoned meat, fish and cereals by farmers and others will be greatly facilitated.

DEPARTMENT OF HORTICULTURE

Frank A. Waugh in Charge

Turf Management. (L. S. Dickinson). The results of past studies of the appearance and control of the large brown patch disease (*Rhizoctonia solani*) were published in *Phytopathology* for August, 1930, under the title "The effect of air temperature on the pathogenicity of *Rhizoctonia solani* parasitizing grasses on putting green turf." Field observations again verified the results obtained in previous years, and each attack of the disease was accurately forecast during the 1930 season.

Further progress has been made in the use of fertilizers to maintain healthy turf during periods of extreme drought, especially where artificial watering is impractical. It appears that certain combinations of fertilizers can offset to a considerable degree the disadvantages of a dry season and produce excellent turf.

Studies in the control of mouse-ear chickweed (*Cerastium vulgatum*) and

pearlwort (*Sagina procumbens*) have been started and should prove of value to growers of fine turf.

The series of plots established in cooperation with the United States Golf Association is furnishing data particularly valuable to golf-course management and of equal use to cemetery and park superintendents. The soil of the plots is of clay loam, thus furnishing unusual opportunities for observations concerning earthworms and the growth of grass as affected by the compactness of the soil. These plots are also giving information regarding the effect of fertilizers on weed invasion.

Several additional species of grasses have been placed in the trial plots.

DEPARTMENT OF PLANT AND ANIMAL CHEMISTRY

J. B. Lindsey in Charge

The Effect of Fertilizer and Cultural Treatment on the Nitrogenous Compounds of Havana Seed Leaf. (E. B. Holland and E. Bennett). Analytical work on the several grades of Havana tobacco grown on the experiment station plots under different fertilization and cultural treatment has been continued. The plants were harvested at different stages of growth, cured on the stalk, stripped and sorted. After the midrib and several coarse laterals had been removed, the residual web was ground and analyzed, with attention directed largely to the nitrogenous compounds. In many instances the number of replications was insufficient to establish a positive trend. Furthermore, seasonal variations in growth and curing and possible differences in drawing and sorting small samples have to be considered. The following deductions seem warranted.

(1) The percentage of total, soluble, and amido nitrogen increased in the several grades from the base of the plant upwards; the nicotine increased from the base of the stalk to the light or medium wrappers, and the acid soluble and insoluble ash decreased.

(2) Low topping increased the percentage of total nitrogen, soluble nitrogen, nicotine and acidity in seconds and reduced the acid soluble and insoluble ash.

(3) The percentage of total, soluble, and ammoniacal nitrogen, acid soluble ash and acidity decreased with maturity in seconds and darks, while nicotine and insoluble ash increased.

(4) An increase in applied nitrogen increased total nitrogen, soluble nitrogen and acid soluble ash within narrow limits, but as a whole affected the yield and size of leaf rather than composition.

(5) Nitrate of soda and sulfate of ammonia increased the total nitrogen in seconds more than the regular tobacco fertilizer mixture or cottonseed meal. Nitrate nitrogen and nicotine were low on cottonseed meal. Sulfate of ammonia increased acidity as would be expected, and nitrate of soda gave the least acidity.

(6) Timothy in the rotation increased the percentage of soluble nitrogen, ammoniacal nitrogen, nicotine and acidity and reduced the percentage of acid soluble ash.

(7) Continuous tobacco gave a slightly higher percentage of total, soluble, and ammoniacal nitrogen, acid soluble ash and higher pH than tobacco following onions or potatoes.

In addition to the chemical studies here reported, the yield, grades, and market value of Havana tobacco grown on the experiment station plots under different fertilization and cultural conditions have been compiled.

Oil Sprays. (E. B. Holland). The preparation of numerous miscible oils and stock emulsions with diamond paraffin oil (a light lubricating oil) and different emulsifiers has been continued and the stability against stratifying and breaking on test noted. The work is time consuming as it is largely on a trial and error basis¹. As a whole the miscible oils prepared by spontaneous methods are the most promising, easy to make, and relatively inexpensive. The laboratory samples applied last spring gave satisfactory results in the field.

The work should be continued with a medium paraffin oil.

Nitrogen Fixation in the Presence of or as a Result of the Growth of Legumes versus Non-Legumes under Certain Defined Agronomic Conditions. (F. W. Morse). This year (1930) all the plots were seeded with Japanese millet. Conditions were favorable for uniform growth until July 22, when a short, severe thunderstorm beat down the millet on the plots fertilized with nitrogen, which inhibited subsequent growth up to the date of cutting (August 19) and also caused a heavier stubble to be left on the field.

A comparison of the annual production with and without nitrogen for both systems of cropping is presented for this and the preceding years. The plots selected for comparison are adjacent to each other; Plot 9 which has not received nitrogen since 1882 and Plot 10 which has received organic nitrogen throughout the period. During this study the applications of nitrogen have been made in alternate years, 1924, 1926, 1928, and 1930. Plot 10 received a total of 80.9 kilograms of nitrogen per acre in the form of dry ground fish.

Scanning the results with leguminous crops used in rotation, it will be noted that clover did not respond to the use of nitrogen in the fertilizer whether applied directly as in 1924 or the previous year as in 1929. Soy beans, however, did respond to the direct application of nitrogen in 1926, especially in the amount of nitrogen recovered in the crop. Corn was grown in the years when nitrogen was withheld, but showed some gain due to the previous season's application. Millet in 1930 received a direct treatment with nitrogen and responded, especially in the yield of nitrogen in the crop.

The results with continuous non-leguminous crops show very plainly their response to applications of nitrogen in the fertilizer.

The objective of the experiment, however, was to ascertain whether or not there was fixation of nitrogen in the soil in the absence of leguminous plants. It will be noted that as the years have passed the three kinds of crops, grass, corn, and Japanese millet, without nitrogen, have gained in production of dry matter and yield of nitrogen instead of decreasing as one might expect if no nitrogen was being fixed.

Similar comparative results were obtained with adjoining plots, No. 7

¹ Some ratios seem to indicate that there may be a fundamental reaction involved.

without nitrogen and No. 8 which received 80.9 kilograms of nitrogen per acre in sulfate of ammonia.

It is planned to continue the investigation.

LEGUMINOUS CROPS GROWN IN ROTATION
(Kilograms of Dry Matter and Nitrogen removed per Acre)

Year	Crop	Without Nitrogen		With Nitrogen	
		Dry Matter	Nitrogen	Dry Matter	Nitrogen
1924	Clover	1866	49.8	1792	46.5
1925	Corn	1766	29.8	1816	31.3
1926	Soy Beans	1596	39.9	1860	50.0
1927	Corn	1164	18.5	1310	23.0
1928	Clover and Weeds	1334	18.9	1340	17.1
1929	Clover	1852	41.9	1714	37.9
1930	Millet	2575	32.7	3011	43.2
Total		12153	231.5	12843	249.0

NON-LEGUMINOUS CROPS GROWN CONTINUOUSLY

Year	Crop	Dry Matter	Nitrogen	Dry Matter	Nitrogen
1924	Grasses	496	4.6	1393	10.1
1925	Corn	1010	13.1	1280	18.5
1926	Millet	2126	14.0	4286	36.5
1927	Corn	1294	21.5	1258	22.8
1928	Grasses and Weeds	1478	13.2	1846	17.9
1929	Grasses	617	6.0	1055	10.8
1930	Millet	3066	29.3	2984	40.6
Total		10087	101.7	14102	157.2

Chemical Study of Cranberries. (F. W. Morse). The work of the last four years has been issued in Bulletin No. 265, "A Chemical Study of Cranberries".

Milk Substitutes in the Growing of Young Calves. (J. B. Lindsey and J. G. Archibald). For a part of the year 1929 and during 1930 studies have been in progress of a system based largely upon dry feeding, no liquid except water being fed after the first few weeks.

The first group of nine high-grade Holstein calves, five bulls and four heifers, was fed on the so-called New Jersey ration consisting of whole milk for three weeks, decreasing the same during the fourth week so that at the beginning of the fifth week the calves were receiving only dry feed, consisting of alfalfa for roughage and a grain mixture containing some 12½ per cent of soluble blood flour. The calves did fairly well and averaged 231 pounds (200-287) in weight at four months of age, making an average daily gain of 1.15 pounds.

A second group of five calves, three bulls and two heifers, was fed in the same way, except that rowen was fed in place of alfalfa. They averaged 228 pounds (210-238) in weight at four months of age, with an average daily gain of 1.12 pounds.

A third test is now in progress in which white fish meal was substituted for the blood flour. The calves did not take to the grain ration as readily because of the odor of the fish meal. Three records have been completed and two others are in progress. The three completed records show an average weight of 227 pounds at four months of age and an average daily gain of 1.02 pounds.

While it is possible to grow Holstein calves by the dry method of feeding, it is not to be commended. Most of the calves appeared thin, "pot bellied," and not in as satisfactory condition as those receiving a portion

of natural skim milk or diluted skim milk powder until four months old. It is believed that very young calves should be given a vigorous start by feeding some form of milk as a part of the ration until they are at least four months of age. (See Bulletin 253 of this Station). They should not be converted into cud chewers too early.

Mineral Requirements for the Growth of Dairy Heifers. (J. B. Lindsey and J. G. Archibald). A study of the calcium requirements has been completed, using eight high-grade Holstein heifers. They were divided into two groups: one was fed a ration high in calcium while the ration for the other group was low in calcium. The average age of the heifers was 140 days at the beginning and 858 days at the end of the experiment, or time of calving. The ration for the high-calcium group consisted largely of alfalfa hay, together with dried beet pulp and a grain ration made up mostly of corn meal; for the low-calcium group hay of mixed grasses (with 30 per cent alfalfa during the first period), dried apple pomace, and corn and linseed meals. Seventy-six satisfactory metabolism balance trials were completed. The detailed data and discussion of results have been prepared for publication and sent to the *Journal of Agricultural Research*.

The results, as a whole, point to accumulation of a considerable reserve of all elements by the high-calcium group during the first year and a lowering of retention later on. The low-calcium group, on the other hand, not having accumulated such a large reserve in the earlier stages, must have felt the need of more calcium and made the effort to utilize it to a greater degree in the third year.

BALANCE RECORD OF RETENTION FOR EACH GROUP DURING THE ENTIRE EXPERIMENT

	Daily retention		Daily retention per 100 lbs. live weight		Retention percentage of intake	
	High calcium group	Low calcium group	High calcium group	Low calcium group	High calcium group	Low calcium group
	Grams	Grams	Grams	Grams	Per cent	Per cent
Nitrogen	25.49	18.73	3.49	2.88	21.12	18.20
Calcium	7.74	4.45	1.06	0.68	17.76	21.60
Phosphorus	3.52	2.15	0.48	0.33	27.36	14.83
Magnesium	0.22	-0.48	0.03	-0.07	1.42	-3.18

The establishment of approximately a 2 to 1 ratio between the amounts of calcium and phosphorus retained, irrespective of the ratio in the intake, was very uniform in both groups and at all ages.

The records of weight and height at withers did not show that one group made any better growth than the other, in spite of the larger assimilation of the elements by the high-calcium group. On the basis of the results secured, it would seem to be a reasonable conclusion that heifers can make satisfactory growth on rations supplying approximately 4.5 grams of calcium daily during the first year of life, 3 grams daily during the second year, and 2.5 grams daily during the third year, for each 100 pounds of live weight. A good quality of hay with 30 per cent of legume hay or rowen during the first year will supply these amounts, while legume hay for roughage will be necessary to supply such amounts as were retained by the high-calcium group.

Two Systems of Dairy Cattle Feeding—High Roughage and Low Grain versus Low Roughage and High Grain. (J. B. Lindsey and J. G. Archibald). This project was organized and started in the autumn of 1928 and is intended to continue for at least three years. The object has been to make careful observations, under controlled conditions, of the effect of maximum roughage and low grain (1 pound to $4\frac{1}{2}$ pounds milk) fed to one group of cows, and minimum roughage and high grain 1 pound to $2\frac{1}{2}$ pounds milk) fed to another group, upon the economy of milk production and the condition of the cows as regards appearance, live weight, and breeding. The roughage has consisted of first cut hay, rowen, silage, and green forage fed in different amounts; and the grain, of a mixture of wheat bran, ground oats, corn meal, gluten feed, and cottonseed meal, mixed in different proportions for the two groups.

The results for the first year ending in October, 1929, showed very little difference between the two groups. At this writing, data for the year ending October, 1930, have not been completed.

The Chemical Composition of Grass from Plots Fertilized and Grazed Intensively. (J. G. Archibald). Results for 1929 have been published in the *Journal of Agricultural Research*, Vol. 41, No. 6, for September 15, 1930.

The fertilizer treatment decreased considerably the dry matter content of the grass and the crude fiber content of the dry matter. All other constituents of the dry matter that were determined were increased, the nitrogen showing the most significant rise. Acre production or recovery of all constituents was increased, nitrogen being nearly double that recovered on the check plot. The effect of withholding nitrogen from one plot was very marked.

The conclusions reached in the earlier publication (see Annual Report for 1929) regarding (1) increase in nutritive value due to fertilization, (2) absence of any appreciable effect of the treatment in leveling seasonal fluctuations, and (3) changes in chemical composition of the grass as the season advanced are substantiated and strengthened by the results of 1929.

A careful study of all results for both seasons (1928 and 1929) and correlation of these with the weather records leads to the further conclusion that of all the factors influencing the chemical composition of grass, producing as they do marked seasonal fluctuations, the amount of rainfall is the most important.

The study has been continued during 1930, but results are not yet available. It is planned to bring this phase of pasture grass studies to a conclusion with the publication of the present season's results.

As an outgrowth of the above study and in response to a demand for more fundamental information on pasture problems, a more complete project entitled "Studies in the Chemistry of Pasture Grass" was organized early in the year. The objective in this project is to ascertain the fundamental chemical facts which agronomists and animal husbandmen need as a basis from which to start in their study of the agronomic and nutritional phases of the problem, and upon which to base recommendations in practice.

In connection with this work 154 samples of pasture grass have been collected during the past season, and analytical work at date of writing (December 16, 1930) is about half completed.

DEPARTMENT OF POMOLOGY

F. C. Sears in charge

The yield of apples and peaches from the station orchards in 1930 was by far the largest in recent years. The quality was also good. Bloom was heavier than usual, and the crop harvested was more than twice that of last year.

The Interrelation of Stock and Scion in Apples. (J. K. Shaw and J. S. Bailey). The usual observations of growth, bloom and yield have been continued. In some parts of the orchard the trees are crowding each other, and a general thinning out of the orchard is necessary. The results of this work suggest that root influence is more likely to dwarf a variety than to invigorate it. The results from the main orchard have been summarized and will soon be prepared for publication.

The young orchard of McIntosh and Wealthy set in 1928 has made a good growth and shows that the East Malling Stocks have a strong influence on growth. The trees are much dwarfed by stocks 8 and 9, while 12 and 16 have thus far developed trees equal in vigor to budded or own-rooted trees. The two varieties are influenced about alike except that there is a striking difference when propagated on stock No. 1, which dwarfs the Wealthy distinctly while McIntosh makes a fairly vigorous tree.

Root cuttings from five-year-old Malling Stocks gave poor results, while scions grafted on nurse roots started well, as did rooted layers. An effort is being made to increase the supply of these Malling Stocks.

Tree Characters of Fruit Varieties. (J. K. Shaw and A. P. French). Work on this project has continued both in Amherst and in various nurseries. A nursery containing nearly 150 varieties of apples, including all varieties commonly grown by nurserymen, has been established. Detailed observations and photographic records will be made. The leaders of this project have continued the work of certifying varieties in certain nurseries for several years. Recently the practice of examining all trees when one year old has become established. Thus the propagation of mixtures is avoided and the stock in these nurseries is now almost free from misnamed trees.

The Genetic Composition of Peaches. (J. S. Bailey). No additional crossing work was done in 1930. Of the 1260 seedling trees from previous work in the orchard, 717 fruited for the first time. Of those fruiting, 289 seedlings are crosses and 428 selfed. The fruits of 275 seedlings are white fleshed and of 442 yellow fleshed; 119 are clingstones, 22 semi-cling, and 576 freestones. Fifty-three seedlings are considered worthy of further observation. Yield was better in the higher parts of the orchard where more fruit buds survived the winter. Hence yield was more dependent on hardiness and location in the orchard than on inherited ability to form fruit buds.

Although one year's results are not enough to draw conclusions from, yet certain statements can be made when the results check with the work of other investigators. The reniform type of foliar glands is dominant, glandular is recessive, and globose is intermediate. White flesh color is dominant, and yellow recessive. Belle is a heterozygous white. Hale,

Chile, Gold Drop, Crosby, Fitzgerald, and Elberta seem to be fairly homozygous for ripening date, while Belle and Champion are heterozygous. Vainqueur, Greensboro, and Carmen seem to transmit earliness in crosses. A character for very tough flesh appeared in the selfed progeny of Champion and Belle. It appears to be recessive.

The work with the freezing apparatus was continued. Not enough data have been obtained to draw conclusions, but length of exposure to cold and previous exposure to high or low temperatures seem to be important factors in influencing the killing temperature, as well as rate of temperature fall. Lowering the temperature to near the killing temperature and then holding it there for twenty-four hours offers some promise as a method for determining the relative hardiness of varieties and seedlings.

Testing Methods of Pruning. (J. K. Shaw). The project with young bearing trees has been carried on as before. The weights of prunings and growth, bloom and yield were recorded. No new or striking results have appeared, and at present it seems that this experiment suggests lessened rather than increased importance of pruning. While the pruning of bearing apple trees will doubtless be continued, its effect on the crop is probably far less than that of soil management or spraying.

Effect of Pruning on Bearing Apple Trees. (W. L. Cutler). This experiment on trees now forty years old is in its fourth year. No striking differences in size, color, or quality of the fruit have yet appeared. The evidence now available indicates that heavy pruning has, on the whole, decreased yields; and that light pruning may have given somewhat greater yields than no pruning.

Comparison of Cultivation and Sod in a Bearing Orchard. (J. K. Shaw). This experiment has continued as in the past four years. The cultivated plots without fertilizer gave a fair crop of high color this year, yet much less than fertilized plots. The highest yield for the four-year period has been from the cultivated plot receiving nitrogen, but the color is not quite as high as that from the sod-nitrogen plot. There seems to be a benefit from the addition of potash to nitrogen on sod plots, but as this potash plot has always yielded more than the one without nitrogen a careful analysis of more data is needed before final conclusions may be drawn.

Comparison of Clover Sod and Grass in Sod Mulch Orchard. (J. K. Shaw). The white clover on the potash-phosphorus-lime plots continues to increase, but the yields of apples are still better on the nitrogen-phosphorus-potash plots. Determination of nitrates in soil from clover patches and from adjoining grass areas gave at no time higher nitrates in the clover. Growth and yield have been better on the clover plots than they were on nearly unfertilized sod plots.

Tests of Different Amounts of Nitrate of Soda. (J. K. Shaw). The Baldwin trees in sod receiving 10, 17½ or 25 pounds of nitrate of soda gave a heavy crop this year. The color was inferior, but there was no difference between lots that had received different amounts. It is now planned to apply nitrogen in the non-bearing year only for a period of years to see whether color is improved and yields maintained.

Comparison of Cultivation and Heavy Mulching for Apples and Pears. (J. K. Shaw). The mulched plots continued to yield heavily, the McIntosh trees averaging nearly 30 bushels per tree while one tree yielded a total of 48 bushels. This comparison has continued for eight years and

seems to have demonstrated the superiority of heavy mulch over cultivation, both being without added fertilizer. It is planned to make some change in the test as it has been proved that a program of cultivation without fertilizer will not maintain production on this soil.

The Effects of Fertilizer Limitation on Fruit Plants. (J. K. Shaw). The fruit plants (apple, peach, grape, raspberry) that have been on this experimental field were removed in the spring of 1930. The fertilizer treatment was continued, and a crop of buckwheat grown and not removed. It is planned to reset the field in the spring of 1931 to own-rooted trees. These field plots with their long-continued fertilizer treatments serve as a source of soil for certain pot experiments.

Role of Potash and Lime in Fruit Tree Nutrition. (J. K. Shaw). A set of pot cultures similar to those of last year but with different fertilizer treatments were grown. Applied nitrates increased growth only to a small degree. Magnesium-free calcium carbonate was as effective without as with added magnesium sulfate. It seems clear that this soil having a pH value of about 4.75 is too acid for the best growth of fruit plants.

Effect of Potash and Lime on Apple Trees. (J. K. Shaw). This project has been carried on without change. Determinations made at several times during the summer showed that soil nitrates were present on plots receiving no nitrogen-carrying fertilizer and also on some of the plots receiving nitrogen, though most such plots showed rather small concentrations at times. No nitrates were present on white clover areas on the phosphorus-potash-lime plot.

Study of Varieties of Tree Fruits. (J. K. Shaw and O. C. Roberts). The station continues to add new and promising varieties of fruits to its test orchards. All the more prominent "bud sports" of apples are under observation. There was an excellent crop on the new peach varieties received from the New Jersey Experiment Station. Most of these are promising and merit a trial by Massachusetts growers. There seem to be among them varieties that are worthy to replace most of the varieties now commonly grown with the exception of Elberta. The Ideal peach of New Zealand, received from the United States Department of Agriculture, gave a heavy crop of attractive peaches that seemed promising for home canning. The Newburgh raspberry, originated at the New York Experiment Station, gives promise of being a desirable mosaic-resistant variety. The Macoun apple seems to be a variety that should be tested generally in Massachusetts orchards.

Fruit Bud Formation in the Strawberry. (R. A. Van Meter). This project was carried out as outlined in the last report and a new bed, with some modifications of treatment, set for fruiting in 1931. This bed includes fertilizer treatments as follows:

1. No nitrogen
2. August 15, nitrate of soda
3. August 15, sulfate of ammonia
4. August 15, urea
5. September 15, nitrate of soda
6. September 15, sulfate of ammonia
7. September 15, calurea
8. October 1, sulfate of ammonia
9. October 15, sulfate of ammonia

All plots are in quadruplicate and received applications of phosphorus and potash.

Three series have been added with treatments of phosphorus, phosphorus-potash and no fertilizer.

Bud Mutations Among Apples and Other Fruits. (B. D. Drain and W. H. Thies). A considerable number of selections from bud sport limbs and prospective mutation strains were made during the past year, and top grafted into trees of bearing age. These grafts grew nicely during the past season.

Light Pruning of Young Grape Vines. (B. D. Drain). The work of this project has been carried on for three years, with results similar to those reported in 1928. Leaf area measurements show a much larger leaf area on the light pruned vines.

Work not on a Project Basis. As in previous years considerable work, not formally organized on a project basis, has been carried on. This is either of a temporary nature or is preliminary to project organization. Some of it is carried on by members of the department not officially members of the Station Staff.

The "Set" of McIntosh Apples in Middlesex and Worcester Counties. This problem largely disappeared in the season of 1930 when most orchards set and matured good crops. It will doubtless return in later years, for the peculiarity of the variety will not change. Cooperative tests were carried out by some fourteen growers to learn something of the response of their orchards to certain treatments, mostly varying fertilizer and cultural treatments.

Blueberry Culture. (J. S. Bailey). For several years some work has been carried on with blueberries. This has been largely on propagation. One of the greatest difficulties in developing blueberry culture is the high cost of plants due to a lack of general knowledge of successful methods of propagation. Cuttings have been grown in ordinary cold frames and in a solar frame. Some progress has been made, and it is hoped that in the near future it will be possible to grow plants from cuttings with good success.

A Study of the Storage of McIntosh Under Various Conditions. (O. C. Roberts in cooperation with the Agricultural Engineering Department). This is the second year of this cooperative investigation of the most desirable storage conditions for McIntosh apples. Similar lots of McIntosh apples were stored at temperatures ranging from 45° F. to 32° F. After approximately two months, samples of each lot were transferred to 32° F. Periodical observations and tests were made to determine the condition of each lot.

The project has been extended to include a comparison of the blower type of refrigeration with the common direct expansion system with pipes extending along the walls. Samples of McIntosh apples were stored in various farm storages equipped with blowers, and duplicate lots were stored in the Nashoba cold storage at Ayer. Periodical observations were made and changes noted. Accurate data relative to the conditions in the various storage houses were also collected at frequent intervals.

Test of Spray Materials. (O. C. Roberts). Constant effort is being made by manufacturers and experiment stations to discover new materials and combinations which will enable the fruit grower to control the numer-

ous pests in his orchard without causing injury to the trees or fruit. In order that the effect of these materials may be determined for Massachusetts conditions, the Departments of Pomology and Entomology co-operating have made field tests of a few of those materials which have appeared to be of particular interest to Massachusetts fruit growers. Details of these tests are given in the report of the Department of Entomology.

Studies of Arsenical Residue on Apples. (O. C. Roberts). For the past four years a study of the amount of arsenical residue on apples as related to different spray schedules has been conducted by the Departments of Pomology and Entomology and the U. S. Food, Drug, and Insecticide Administration at Boston. This experiment is discussed in the report from the Entomology Department.

Cross-Pollination and Sterility Studies with Certain Apple Varieties. (F. C. Sears and O. C. Roberts). For the past six years the Pomology Department has been making a study of the effects of pollination on the set of fruit. Particular attention has been given to the McIntosh, the most important variety in Massachusetts. McIntosh is practically self-sterile, but appears to be a good pollenizer for other varieties. A few of the most reliable pollenizers for McIntosh are Wealthy, Delicious, Oldenburg, Ben Davis, and Cortland.

Pruning of Northern Spy Trees. (O. C. Roberts). In 1927 the trees in a small block of young Spy trees were divided into three groups. Each group has since been given different pruning treatments as follows: (1) Unpruned, (2) Heavy pruned, (3) Branches spread and lightly pruned. These trees have just begun to bear, so data on the effect of the various treatments on quantity and quality of fruit are as yet very limited. However, there seems to be an indication that the trees with branches spread and lightly pruned are more desirable than the others.

DEPARTMENT OF POULTRY HUSBANDRY

J. C. Graham in charge

Broodiness in Poultry. (F. A. Hays). Progress is being made in establishing a non-broody and an intense broody line of Rhode Island Reds. A pen of 13 hens in the non-broody line ranging in age from two to five years was given access to open nests from April 20 to August 1, 1930, in studies on the effect of management upon broody behavior. Non-broody birds are being tested genetically for the complementary genes responsible for broodiness.

The intense broody line is being studied, with special reference to the inheritance of degrees of broodiness measured by number of broody periods. The non-broody and the intense broody lines are being developed with special reference to uniformity in other inherited characteristics, in order that the effects of broodiness may be accurately determined.

Breeding Poultry for Egg Production. (F. A. Hays and Ruby Sanborn). The mean annual production of the 352 birds hatched in 1928 was 221.4

eggs, an increase of about 16 eggs over any previous flock. This increase was brought about by superior intensity and greater persistency in the flock as a whole. Special attention is being given to improving egg size, reducing mortality rate, and eliminating winter pause. Mean egg size is improved, and the mortality rate for the 1928 flock for the full laying year was 14.85 per cent. Hatching records for the entire flock for the spring of 1929 show 77.7 per cent of fertile eggs hatched; for the spring of 1930 the figure was 74.5 per cent. These hatching records show progress, and include only eggs hatched under conditions used in pedigreeing.

Statistical Study of Heredity in Rhode Island Reds. (F. A. Hays and Ruby Sanborn). Annual molt records from 1917 to 1928 were studied statistically and published in Bulletin 264. A paper on linkage relation for genes concerned in fecundity and genes concerned in egg size was prepared for the 4th World's Poultry Congress in London, July, 1930. Studies on time required for pullets to attain standard egg weight were reported at the 1930 Poultry Science meeting at Macdonald College.

A Genetic Study of Rhode Island Red Color. (F. A. Hays). In this experiment three strains are being developed: One is made up of pure Station stock selected for good color, a second consists of birds true to Standard from an outside source, and the third is made up of hybrids of the other two strains.

Determination of Genetic Laws Governing Results in Inbreeding Poultry. (F. A. Hays). Results of this project up to 1929 were reported in Bulletin 258. In the spring of 1929 the method of experimentation was changed somewhat in that the more rigid standards for selecting foundation breeding stock for high fecundity were employed. A new generation was established in 1929 in a special effort to avoid any inherited characteristics inimical to high fecundity. The second generation was produced in the spring of 1930 from half-brother and sister matings.

Heredity and Environmental Characteristics Affecting Variability in Egg Production. (F. A. Hays). The third generation of pullets in this experiment is now being tested for egg production. There are three rather distinct lines represented with respect to characteristics affecting fecundity. Data should be adequate for publication at the close of the laying year in 1931.

Factors Affecting Egg Weight and Shell Character in Domestic Fowl. (F. A. Hays). Complete egg weight records from first pullet egg to January 1 are available on 2100 birds hatched in 1927, 1928, and 1929. Records on the weight of every egg laid by 500 females during their first laying year are also available. The third generation of birds in the small, medium and large egg groups was hatched in 1930. Sufficient data should be available for publication at the close of 1931. The application of methods already reported has produced improvement in egg size for the flock as a whole.

Relation of Intensity or Rate of Laying to Feather Pigmentation. (F. A. Hays). Results of this project are being prepared for publication.

DEPARTMENT OF VETERINARY SCIENCE

J. B. Lentz in Charge

Poultry Disease Elimination Law. (H. Van Roekel, K. L. Bullis, G. L. Dunlap, and O. S. Flint). The progress made in pullorum disease eradication during the 1929-1930 season is reported in Control Series Bulletin No. 53. Approximately one-seventh of the poultry population of Massachusetts was tested and the volume of work is steadily increasing. Compared with the previous season the following increases are noted:—48 tested flocks, 76,802 tested birds, 82,590 tests, 81 negative flocks, and 53 non-reacting 100 per cent tested flocks. Further comparison shows that the average percentage of infection was reduced from 4.25 to 2.35 per cent.

A study of 60 flocks tested for two consecutive years showed that intensive retesting or short-interval testing was more effective in eradicating the disease than annual testing. Similar results were obtained in 30 flocks tested for three consecutive years.

The relation of sexual maturity to pullorum disease eradication was studied in ten flocks which were subjected to the intensive testing plan. The results show that sexual maturity of pullets does not appear to play a role in eradicating the disease. From an eradication point of view, early pullet testing in infected flocks is more desirable than testing more mature birds.

Failure in eradicating the disease or in maintaining a pullorum disease free flock was in most instances due to a lack of observing sound eradication measures. More effective results would be obtained if all poultrymen would follow the laboratory suggestions more closely.

Two hundred and twenty-eight reacting birds were submitted to the laboratory for necropsy. The necropsy findings often aided in establishing the true status of a flock. No reactors were detected among the 584 tested fowl other than chickens.

This laboratory again participated in the annual pullorum conference of the Eastern States' laboratory workers. The purpose of this conference is to standardize and adopt uniform, sound methods which will prove practical and effective in pullorum disease eradication.

Among the blood samples submitted since August 1, 21,123 samples, representing 37 flocks, were tested with *Brucella abortus* antigen in 1-25 and 1-50 dilutions. All samples were considered negative.

An effort was made to determine the length of time *S. pullorum* will remain viable under various conditions. It was observed that the organism can remain viable on a dry piece of cloth in a Kolle flask for fourteen weeks and possibly longer.

The problem of "jelled serum" samples is being investigated. Results thus far show that the number of jelled samples may be greatly reduced if the freshly drawn blood is not subjected to low temperatures.

Laboratory Service—Pathology. (G. L. Dunlap). This service was used by 352 people, 71 making personal calls to deliver specimens or discuss poultry diseases. Ten hundred and seventy-nine specimens were examined, of which 1016 were poultry, the remainder consisting of other

domestic and semi-domestic animals. Approximately 15 per cent of all poultry examined were infested with parasites, led by coccidiosis, with tapeworm infestation second. Avian tuberculosis was diagnosed on two farms. Fowl cholera and fowl typhoid were not encountered.

An especially virulent strain of *S. pullorum* was isolated from mature stock and studied. This culture was physiologically and serologically identical to stock strains of *S. pullorum*. It produced death in two birds injected intravenously with 0.2 cc. of broth culture in 17 and 18 days, respectively, and the organism was again recovered. Two birds inoculated intratracheally with 0.5 cc. of broth culture were made visibly sick for a period of a week, but recovered. The primary lesion produced in these cases was a pericarditis.

A group of 25 day-old chicks were fed mash, which was contained in a bag contaminated with *S. pullorum*, for a period of three weeks. No mortality occurred from pullorum disease. At six weeks of age the agglutination test revealed two reactors. No more reactors were detected by the agglutination test applied at one and two weeks intervals over a period of seven months. *S. pullorum* was isolated from one of the two original reactors which were detected at the age of six weeks.

Farm and Station Bang's Disease. The laboratory, in assisting this project, has recorded 1339 agglutination tests.

Infectious Trachitis in Poultry. (C. S. Gibbs). Progress has been made in the study of infectious trachitis. The disease has been found to be caused by a filtrable virus. The virus has been demonstrated in the tracheal exudate and in the secretions from the kidneys of diseased birds. Some of the birds recovering from infectious trachitis have been found to persist as apparently healthy immune carriers. The viability of the virus is prolonged by freezing and drying.

Studies on secondary invaders in infectious trachitis have been made, and a laryngo-tracheal spirochete has been discovered. As far as is known at this station, this microorganism has not been observed before in poultry in the United States.

Details of these investigations are being prepared for publication.

THE WALTHAM FIELD STATION

(Waltham, Massachusetts)

Ray M. Koon in Charge

For reports on experiments conducted at this substation in addition to these listed under the Waltham Field Station, see reports of the Departments of Botany, Entomology and Floriculture.

The Plant House. (P. W. Dempsey). Experiments have been continued in the construction, heating and operation of a sash-covered plant house. A twelve-sash hotbed was added to the plant-house model and one hot-water heater was used as a source of heat for both. This arrangement proved more satisfactory than using horse manure for hotbed heat. The interest in the plant house is indicated by the fact that 500 copies of plans and specifications have been sent out in response to requests for information.

Electric Hotbed. (P. W. Dempsey). After investigating the practical application of electricity for heating hotbeds in 1928, it was decided that the expense was too great, both for installation and upkeep. During the past year, however, the General Electric Company has introduced a new type of heater and thermostat, economical both in operation and cost. Plans are in the making for operating three hotbeds of four sash each with manure, hot water and electricity as sources of heat, in co-operation with the Edison Electric Illuminating Company of Boston. Notes on the comparative cost, temperature and other details will be kept.

Vegetable Variety trials. (P. W. Dempsey). Twelve varieties and strains of pole beans were tested. Kentucky Wonder proved to be the best both for the market and for home growing. The new variety of Italian Pole may replace the Kentucky Wonder because of its superior quality.

Seed of twelve strains of Calabrese broccoli were secured from as many different seedsmen. A decided uniformity was noted in all samples.

Thirty-seven strains and varieties of sweet corn were tested. Golden Sunshine was the outstanding early yellow variety and shows promise of replacing the once popular Golden Bantam. Golden Gem, a production of the North Dakota Experiment Station, is a very early yellow sort but too small to justify its extensive use for home or market planting.

Twelve varieties of peppers were compared. California Wonder, a new introduction, shows up well and is becoming popular with the growers. Red Sport of Oshkosh (seeds sent to Dr. Guba of this Station in 1929 by a private grower) shows great promise, and a separate plot will be devoted to this variety in 1931 for the purpose of further selection if the variety seems worthy.

Twenty varieties and strains of staked tomatoes, and fifty-four varieties and strains grown flat culture, were studied. There was no outstanding strain or variety.

Six strains of the popular Straightneck variety of summer squash were planted. No strain yet tried runs more than 50 per cent true to type.

Twenty strains and varieties of beets were seeded in two plantings. A great improvement has been noted in the strains of Detroit Dark Red offered by seedsmen the past three years. Crosby's Egyptian, however, remains the most popular and undoubtedly the best variety for Massachusetts growers.

Forty-nine strains and varieties of lettuce, of two plantings each, were made. The best lettuce ever produced at the Field Station was at just the right stage of maturity for Field Day. Many growers were impressed with the new strains of the so-called "White Big Boston" now sold by seedsmen under several names. It appears to be worthy of trial by any grower for sowing at any time during the season.

Conditions Affecting the Production and Vegetative Propagation of Washington Asparagus. **Depth of Planting.** (P. W. Dempsey). In 1928 two hundred selected one-year roots were planted two, four, six and eight inches deep. Next spring the beds will be cut for the first time.

Depth of Planting	No. of Plants	No. of Stalks.	Average Stalks per plant
2	192	1700	8.8
4	197	1551	7.8
6	175	1209	6.9
8	154	1057	6.8

Fertilizer Studies. (R. M. Koon). The plots are located at Waltham, Concord and Eastham. Five acres, in total, are devoted to the plots. A comparison of fertilizer ingredients, time of application of fertilizers, amounts of fertilizer to apply, relation of high phosphoric acid to maturity, and relation of fertilizer to earliness are the principal problems being investigated. Although there were variations between the plots at the end of the 1930 season, there was no correlation between the variations and the treatment of the plots. This experiment will continue until 1934.

Greenhouse Lettuce. (V. A. Tiedjens). Very favorable reports from growers who tried out the Bel-May lettuce in the spring of 1929 resulted in a demand for seed. The Boston Market Gardeners Association sent one-half pound of the foundation stock to a California seed grower who returned 60 pounds of seed last August for distribution among the lettuce growers of this State. One-half of the lettuce produced in the greenhouses of Massachusetts during the season of 1930 is of the new Bel-May cross. It is a superior hotbed variety and shows promise as a satisfactory sort for the early transplanted crop in the field.

Improvement of Vegetable Varieties through Root and Seed Selection. (P. W. Dempsey). The foundation seed stock of the Field Station Hutchinson Carrot was grown as usual.

Further selection of the foundation stock of the Wyman beet was made, preparatory to having a quantity of seed grown under the supervision of the Oregon Agricultural College in 1931.

F₁ selections of the Blue Hubbard squash selfed in 1929 were planted and several excellent specimens were produced this season. Pollination was continued as before.

Seed from the best strains of Dwarf Horticultural beans from last year's trials as well as special strains from several new sources were planted. A few of the strains which showed some promise were saved for special study.

Perennial Ornamentals. (Ray M. Koon). Perennial gardens have been established for the purpose of observing pest attacks, the effect of cultural treatments, hardiness, and for the benefit of the visiting public who are interested in selecting plant material for their own homes. The plots include 675 varieties of flowering plants commonly known as perennials, 100 varieties of Iris, 60 varieties of roses, and 235 new varieties of peonies from the Cornell Surplus of the American Peony Society. A border of 280 deciduous shrubs and trees of eighty-five different species from which home lovers can make selections for simple and practical landscaping has been planted.

Field Day. The annual Field Day was held as usual at the Waltham Field Station the first Wednesday in August (August sixth) with about 900 market gardeners and florists attending.

COOPERATIVE TOBACCO INVESTIGATIONS

Conducted by the Bureau of Plant Industry, United States Department of Agriculture, in cooperation with the Massachusetts Agricultural Experiment Station. C. V. Kightlinger, U. S. D. A., in Charge

Brown Root-Rot. (C. V. Kightlinger). Experimental work on brown root-rot of tobacco, conducted for the last several years at Whately, was terminated with the procuring of data on the 1929 crop. The results of these experiments will be combined with data from similar experiments conducted in Connecticut, Wisconsin, and elsewhere, for publication as a U. S. D. A. bulletin.

Black Root-Rot. (C. V. Kightlinger). Field experiments were begun this year (1930) at Amherst and at Windsor, Connecticut, to test certain strains of Havana seed tobacco produced by and obtained from Dr. James Johnson of Madison, Wisconsin, to determine their relative type, quality, resistance to black root-rot, and producing capacity under Connecticut Valley conditions. Although not all the data have been obtained yet, some of the strains seem promising. The experiments will be continued until definite information on the matter has been obtained.

Mosaic. (C. V. Kightlinger). Experiments have been carried on for more than a year to determine the extent of overwintering of tobacco mosaic viruses in different kinds of soils, under different conditions of temperature and moisture. All that can be said about results is that a high percentage of infection of mosaic is still being obtained from the materials treated as above described. Another set of similar experiments, begun a year later, is also being carried on for the purpose of verification of results already obtained.

PUBLICATION

Bulletins

- 260 Annual Report for the Fiscal Year Ending November 30, 1929. 60 pp. March, 1930.

The main purpose of this report is to provide an opportunity for presenting in published form, recent results from experimentation in fields or on projects where progress has been such as to justify the general and definite conclusions necessary to meet the requirements of bulletin or journal.

- 261 Ecological Studies of the Mexican Bean Beetle. Harvey L. Sweetman and H. T. Fernald. 32 pp. February, 1930.

The Mexican bean beetle was found in Massachusetts and Connecticut for the first time in 1929. A laboratory study of temperature and moisture conditions necessary for the development of the insect is here reported, and the results studied in relation to climatological data for New England. The following conclusions are drawn:

Climatic conditions in the Upper Austral Zone of Massachusetts, Connecticut and Rhode Island are favorable for the development of the Mexican bean beetle, and the insect may therefore be expected to become a serious pest. Conditions in the Transition Zone are less favorable, but the insect will probably become a pest in the lower portion of the Zone, with the injury becoming greatly reduced as the upper limits are approached. The Canadian Zone of New England does not have a physical environment suitable for the development of the beetle. A map of New England showing the three zones is included in the bulletin.

- 262 Intensive Grassland Management. R. C. Foley, E. J. Montague and C. H. Parsons. 17 pp. February, 1930.

The system of grassland management here reported is based on four distinct principles: (1) Division of area into plots; (2) use of concentrated fertilizers; (3) rotational grazing; and (4) combination of grazing and hay land. The system has been in operation here for two years and in spite of two extreme seasons, the first wet, the second dry, has given excellent results. The second year, in the face of a serious drought, it showed greater returns than the first year, and marked improvement in every respect. This two-year trial has proved that the grazing season may be lengthened and the carrying capacity of a pasture increased by the application of the four principles enumerated above, thus lessening the amount of barn feeding necessary.

- 263 Food Service in Massachusetts Rural Elementary Schools. Esther Davies. 19 pp. April, 1930.

This survey covered 222 of the 236 towns of less than 5000 population and included 57,600 pupils housed in 800 buildings. Of these, 567 had no food service whatever; 185 had hot drink or soup during the winter only; in 23 a meal was served during the entire school year; and in 23, milk was available for the children during the entire school year. There were 16,000 pupils who must always remain at school over the noon hour, and of these 6000 attended buildings where there was no food service. An examination of 1560 box lunches showed that 93 per cent of the children carrying them had no hot food at noon, and only 15 per cent brought milk. A description is given of eight different types of food service in use in buildings varying from the one-room schoolhouse with practically no facilities to buildings with full meal service. While the type of service which can be offered is limited by the physical equipment of the building, the examples show that no building is too poorly equipped to make some sort of hot food possible, at least during the winter months. Much remains to be done in establishing and improving school lunches; and with the growing tendency toward consolidation of rural schools, the question is becoming of greater importance each year.

- 264 Duration of Annual Molt in Relation to Egg Production. F. A. Hays and Ruby Sanborn. 14 pp. June, 1930.

A number of factors which may influence duration of molt are considered, as follows: environmental factors, such as hatching date; hereditary characteristics, such as age at first egg, intensity, winter pause, broodiness, and persistency; and physiological activities, such as previous egg production, 365-day production, and gain in body weight during the laying year. Relation of duration of molt to vigor and to second-year production is determined. The study was made with Rhode Island Red birds, and includes all females hatched from 1917 to 1928 and kept for two full laying years. In general, but little correlation was found between duration of molt and the factors studied. Highly intense layers and persistent layers, however, had the shortest molt period, indicating that the physiological process of molting and feather growth took place at a more rapid rate in heavy layers.

- 265 A Chemical Study of Cranberries. F. W. Morse. 16 pp. October, 1930.

A study of the chemical changes occurring in cranberries while ripening on the vines was made during two seasons. Total sugar was found to increase rapidly as the berries ripen, while total acid remained nearly unchanged. Cranberries do not acquire their maximum proportion of sugar until fully ripe on the vines.

Studies of cranberries in cold storage covered two seasons and showed that they steadily lose sugar by respiration. Total acid decreases also, but at a smaller rate. While cranberries remain sound they contain enough acid to maintain their tart flavor.

In the fall of 1929 there were received from growers in Massachusetts, New Jersey and Wisconsin 116 different lots of cranberries representing 61 distinct varieties. These were analyzed for total acid, total sugar and dry matter. The range in percentages of total acid was from 1.87 to 2.71 and in percentages of total sugar from 2.45 to 5.66. Thirty-five samples contained more than 4.5 per cent of sugar; 49, between 3.5 and 4.5 per cent; while 32 contained less than 3.5 per cent of sugar. The samples lowest in sugar were, as a rule, only partly ripe when harvested.

Ten varieties resisted decay in cold storage to the extent of 60 per cent of sound berries on April 1, 1930; four varieties had all their samples fully half rotted by January 15; and the remaining varieties were in that condition by the end of February.

- 266 Part-Time Farming in Massachusetts. David Rozman. 44 pp. October, 1930.

A study was made of three representative areas in Massachusetts, and with two main objectives. In Holden, in the central part of the State, the object was to determine the extent of part-time farming in the community as compared with regular agriculture. Of the 585 families engaged in some kind of farming, only 66 were full-time farmers. Land in crops and total value of products were almost evenly divided between regular and part-time farming. Although the production in most part-time farming enterprises is intended primarily for family consumption, the surplus sold amounted to over one-third of the total value of produce offered for sale by local producers. Part-time farming, therefore, exercised a considerable influence on local prices and marketing conditions of agricultural products.

In the other two areas, four towns adjacent to Lowell and four towns between Taunton and Fall River, the aim was to get a picture of the social and economic status of industrial and other laborers who are engaged in part-time farming. This mode of living was adopted for the most part as a means of increasing earnings and living more cheaply, or in the hope of improved health and better housing for their families. Two main types of part-time farming were found. The greater number had a regular job at which they worked, and did what farming they could in their spare time, with the help of their families. As a rule they raised vegetables or kept chickens or both, and the amount of work required was fairly regular throughout the year. A considerable number, however, engaged in truck farming or small fruit growing, devoting their entire time to it during the season and working at outside jobs only during the months when this type of farming does not require attention.

The development of part-time farming depends upon improvement in transportation facilities, shorter working hours in industry, and the location of industrial plants in small towns and rural communities. Indications are that part-time farming has been increasing in the State during the last decade and that the next ten or twenty years will show a further increase.

- 267 Hardy Woody Plants. Frank A. Waugh and Charles H. Thompson. 36 pp. October, 1930.

Hardy trees, shrubs, and vines are a very important feature of our civilization. Country roadsides and village streets are planted with trees; parks and playgrounds must have their trees and shrubs; but, most of all, the home grounds are not considered quite respectable unless trees, shrubs and vines are used to soften and civilize the architecture and the topography. Hardy woody plants have been under study for sixty-five years on the grounds of the Massachusetts Agricultural College, and this bulletin is intended to make some of the results of these studies available. A list of over three hundred plants is given, with a brief description of the chief characteristics of each and its performance under conditions found on this campus.

- 268 Frozen Sweet Cream as an Ingredient of Ice Cream. M. J. Mack. 11 pp. December, 1930.

The storage of cream in a frozen state is a satisfactory way of handling surplus cream for later use in ice cream, the quality of the frozen cream depending upon its initial quality, the length of time held in storage, and the storage temperature. Holding periods of less than six months and storage temperatures below 0° F. are recommended. Frozen cream mixes required a longer time in the freezer to reach a definite percentage of overrun than sweet cream mixes and showed a lower maximum overrun. Frozen cream mixes were higher in viscosity and contained slightly larger and more irregular-sized fat globules and clumps.

Ice cream mixes containing cream frozen with 0.5 per cent gelatin whipped but little better than plain frozen cream mixes. Homegenizing the cream before freezing did not improve its properties for ice cream making. Freezing cream with 10 per cent sugar was the most satisfactory method studied for storing frozen cream for later use in ice cream. The frozen sweetened cream melted more rapidly than plain frozen cream, was lower in viscosity and much more uniform in body. Ice cream mixes made from frozen sweetened cream were superior in flavor to plain frozen cream mixes, whipped considerably faster in the freezer, were lower in viscosity, and contained smaller fat globules and clumps.

269 Packaged Ice Cream. K. E. Wright. 12 pp. December, 1930.

The public has been slow to accept factory-packaged ice cream on account of its lighter weight and poorer texture.

The problem of weight can be most logically solved by drawing the mix at an overrun of about 50 per cent, although the light weight can be partially compensated by increasing the percentage of butterfat or by reducing the price to a weight basis or by a combination of these. Because of the low overrun required in packaged goods, it was found necessary to retard the overrun of easily whipped mixes in order to enable the drawing of the mix at the proper consistency. The substitution of butter for a part of the cream was found to be the most effective practical means of effecting a low constant overrun.

The texture of the ice cream as influenced by freezing was largely determined by the temperature of the semi-frozen product at the beginning of the hardening process. The rate of freezing in the ordinary freezer and in the hardening room was found to be a minor factor in influencing the texture in comparison to the initial hardening temperature. The size of the crystals determining the texture seems to be influenced by a specific range of temperature depending on the mix rather than by a progressive lowering of the drawing temperature of the mix. The results showed that the texture improvement due to gelatin and aging was caused by aging the gelatin, and that the effect on texture was more noticeable when a warm initial aging temperature was employed.

Control Bulletins

- 53 Tenth Annual Report on Eradication of Pullorum Disease in Massachusetts, 1929-1930. H. Van Roekel, K. L. Bullis and G. L. Dunlap. 23 pp. May, 1930.
- 54 Inspection of Commercial Fertilizers. H. D. Haskins. 64 pp. December 1930.
- 55 Inspection of Commercial Feedstuffs. Philip H. Smith. 44 pp. December, 1930.
- 56 Seed Inspection. F. A. McLaughlin. 42 pp. December, 1930.
- 57 Inspection of Agricultural Lime Products. H. D. Haskins and H. R. DeRose. 6 pp. December, 1930.

Meteorological Reports

493-504, inclusive. Monthly reports giving daily weather records, together with monthly and annual summaries.

Reports of Investigation in Journals

(Numbered Contributions¹)

- 101 Mineral Supplements for Dairy Cows. J. B. Lindsey and J. G. Archibald. Jour. Dairy Sci. 13:102-116. March, 1930.
- 102 Nitrogen Fixation in Field Soil under Different Conditions of Cropping and Soil Treatment. Leon A. Bradley and James E. Fuller. Soil Sci. 30:49-57. July, 1930.
- 104 The Effect of Initial Cooling Temperature on Gelatin in the Aging of the Ice Cream Mix. K. E. Wright. Jour. Dairy Sci. 13:406-415. September, 1930.

¹ Nos. 103 and 108 were cancelled. Nos. 109 and 110 have not yet been printed.

- 105 The Effect of Air Temperature on the Pathogenicity of *Rhizoctonia Solani* Parasitizing Grasses on Putting-Green Turf. Lawrence S. Dickinson. *Phytopath.* 20:597-608. August, 1930.
- 106 Pasteurized Dried Fruits. C. R. Fellers. *Amer. Jour. Pub. Health and Nation's Health* 20:175-181. February, 1930.
- 107 Nitrogen Availability in "Based" and Unbased Ammonium Sulfate and Ammonium Phosphate. A. B. Beaumont and T. R. Swanback. *Jour. Amer. Soc. Agron.* 22:811-819. September, 1930.
- 111 The Chemical Composition of Grass from Plots Fertilized and Grazed Intensively in 1929. J. G. Archibald. *Jour. Agr. Research* 41:491-501. September 15, 1930.

Other Contributions to Journals

(Unnumbered)

- The Relation of Weather to the Quality and Price of Massachusetts Onions. R. L. Mighell and H. B. Rowe. *Jour. Agr. Econ.* April, 1930.
- A Study of the Causes of Cull Apples in 1929. W. L. Doran and A. I. Bourne. *Mass. Fruit Growers' Assoc. Rpt.* 1930.
- Effective Control Measures—Oil Sprays: Nicotine Activators. A. I. Bourne. *Mass. Fruit Growers' Assoc. Rpt.* 1930.
- Fruit Insect Pests of 1929. A. I. Bourne. *Mass. Fruit Growers' Assoc. Rpt.* 1930.
- European Red Mite in New England Orchards. A. I. Bourne. *Fruits and Gardens.* March, 1930.
- Spraying Recommendations in Relation to Bees. A. I. Bourne. *Mass. Dept. Agr. Spec. Cir.*
- The Plum Curculio as an Apple Pest. W. D. Whitcomb. *N. H. Hort. Soc. Ann. Rpt.* 30. 1930.
- Poisoning Plum Curculio Beetles—Mechanical Barriers of Dust and Spray Residue—Reducing the Cost of Nicotine Sulfate Sprays. W. D. Whitcomb. *Mass. Fruit Growers' Assoc. Rpt.* 1930.
- The Grapefruit and its Juice. C. R. Fellers. *The Glass Packer* 2:509-510. December, 1929.
- Roadside Farm Factories as New Factors in Food Preservation. F. P. Griffiths. *The Glass Packer* 2:493-519. December, 1929.
- Canned Foods Are the Freshest Foods. C. R. Fellers. *The Canner* 70:17-18. June, 1930.
- Utilization of Cold Packed Fruits in Frozen Dairy Products. C. R. Fellers and M. J. Mack. *Fruit Products Jour.* 9:106-109. December, 1929.
- Sodium Benzoate and Benzoic Acid as Preservatives for Cider and Other Fruit Juices. C. R. Fellers. *Fruit Products Jour.* 9:113-115. December, 1929.
- Some Newer Developments in the Control of Apple Diseases. E. F. Guba. *Mass. Fruit Growers' Assoc. Rpt.* 1930.
- Automatic Control of Relative Humidity and Temperature Supplementary to Sash Ventilation in Greenhouses. E. F. Guba. *Market Growers Jour.* June 1, 1930.
- Fundamental Principles in Forcing Gladiolus. L. H. Jones. *New England Gladiolus Soc. Yearbook*, 1930.

CHANGES IN STAFF, DECEMBER 1, 1929, TO NOVEMBER 30, 1930**Appointments**

- Bennett, Emmett, B.Ed., Research Assistant in Chemistry, January 1, 1930.
- Clague, John A., B.S., Research Assistant in Horticultural Manufactures, September 1, 1930.
- Cleveland, Maurice M., B.S., Fellow in Horticultural Manufactures, September 20, 1930.
- Donley, J. Elizabeth, B. A., Laboratory Assistant in Agricultural Economics, September 22, 1930.
- Donnelly, Edward B., Technical Assistant in Floriculture, February 1, 1930.
- Flint, Oliver S., B.S., Assistant Research Professor, Poultry Disease Elimination Law.
- Jones, William L., B.S., Fellow in Agronomy, October 1, 1930.
- Koon, Ray M., M.S., Research Professor in Vegetable Gardening, in charge of Waltham Field Station.
- Foley, Richard C., B.S., Research Assistant in Animal Husbandry, April 1, 1930.
- Larsinos, George J., M.S., Junior Chemist, Fertilizer Law, October 1, 1930.
- McLaughlin, F. A., B.S., Assistant Research Professor, Seed Law, September 1, 1930.
- Merriam, Oreana A., B.S., Laboratory Assistant in Home Economics Research, July 1, 1930.
- Parkinson, Leonard R., Technical Assistant in Animal Nutrition, December 21, 1930.
- Spelman, Albert F., B.S., Junior Chemist, Feed Law, January 13, 1930.
- Stuart, William M., Jr., B.S., Research Assistant in Agronomy, October 1, 1930.
- Voorneveld, Madaline, B.S., Laboratory Assistant in Home Economics Research, September 8, 1930.
- Washburn, Doris E., B.A., Research Assistant in Farm Management, September 1, 1930.
- White, Harold E., M.S., Assistant Research Professor in Floriculture, January 1, 1930.

Resignations

- Alcock, James R., Technical Assistant in Animal Nutrition, December 21, 1929.
- Church, Cornelia B., B.S., Laboratory Assistant in Home Economics Research, July 7, 1930.
- Fernald, Henry T., Ph.D., Professor of Entomology and Head of Department, June 30, 1930.
- Jones, John P., Ph.D., Research Professor in Agronomy, June 30, 1930.
- Kelley, Joseph L., Technical Assistant in Cranberries, November 1, 1930.
- Kelly, Oliver W., M.S., Seed Analyst, June 30, 1930.
- Kuzneski, John W., B.S., Junior Chemist, Feed Law, December 31, 1929.
- Rice, Cecil C., B.S., Research Assistant in Horticultural Manufactures, September 1, 1930.
- Shilling, Katherine E., A.B., Laboratory Assistant in Agricultural Economics, September 15, 1930.
- Tiedjens, Victor A., M. S., Assistant Research Professor in Vegetable Gardening, June 30, 1930.
- Zielinski, John B., Jr., B.S., Junior Chemist, Fertilizer Law, September 30, 1930.

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MASSACHUSETTS;
AGRICULTURAL EXPERIMENT STATION

BULLETIN No. 280

FEBRUARY, 1932

Annual Report

For the Fiscal Year Ending Nov. 30, 1931

The main purpose of this report is to provide an opportunity for presenting in published form, recent results from experimentation in fields or on projects where progress has not been such as to justify the general and definite conclusions necessary to meet the requirements of bulletin or journal.

MASSACHUSETTS STATE COLLEGE
AMHERST, MASS.

MASSACHUSETTS AGRICULTURAL EXPERIMENT STATION

Trustee Committee on Experiment Station

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WHITMORE, PHILIP F., Sunderland	1934
RUSSELL, HOWARD S., Waltham	1936
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†*FRANKLIN, HENRY J., Cranberries	‡WHITCOMB, WARREN D., Entomology
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FLINT, OLIVER S., Veterinary Science	
FRANCE, RALPH L., Bacteriology	
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‡GURA, EMIL F., Botany	

* In Charge

† At East Wareham

‡ At Waltham

CONTENTS A

Introduction.....	192
 Department of Agricultural Economics:	
The economic worth to growers of different varieties of apples.....	193
Consumer demand for eggs.....	193
Changing methods of wholesale distribution of perishables.....	193
Analysis of market prices for Massachusetts vegetables.....	194
Recreational and forestry uses of land.....	194
Housing conditions and problems in part-time farming.....	194
Factors affecting the price of eggs.....	194
The relation of quality factors to price of eggs.....	194
Competitive factors influencing the supply of market milk and cream.....	194
 Department of Agricultural Engineering:	
Investigation of apple storages.....	195
Fertilizer distributors.....	195
Test of low-lift pumps.....	195
 Department of Agronomy:	
Pasture experiments.....	195
Legume variety tests.....	196
Field experiments with onions.....	197
Onion breeding.....	197
Field experiments with tobacco.....	198
Nitrogen metabolism in the tobacco plant.....	198
Magnesium requirement of crops.....	199
Method of applying fertilizer to corn.....	199
Fertilizer ratios for grassland.....	199
Nitrogen in golf green clippings.....	199
Lawns and lawn grasses and management.....	199
 Department of Bacteriology:	
Nitrogen fixation in the presence of or as a result of legumes versus non-legumes.....	200
Utilization of mannite by <i>Azotobacter</i>	200
Influence of temperature on the nitrate content of soil in the presence of decomposing cellulose.....	200
Laboratory service.....	201
The indol tolerance of the <i>Colon-Aerogenes</i> group of bacteria as a possible means of differentiating fecal and non-fecal strains occurring in drinking-water supplies.....	201
 Department of Botany:	
Tobacco black root-rot.....	201
Brown root-rot of tobacco.....	202
Onion diseases and the use of fungicides on onions.....	202
Downy mildew of cucumbers.....	202
Acetic acid and pyroligneous acid as soil disinfectants.....	203
Eggplant wilt.....	203
Strawberry gold disease.....	204
Control of greenhouse vegetable diseases.....	204
Carnation blight.....	205
Monograph of the genus <i>Pestalotia</i>	206
Forcing gladiolus with the aid of artificial light.....	206
Eradication of nematodes in greenhouse soils by the use of chemicals.....	206
Plant containers.....	206
Influence of light quality on plant growth.....	207
Plant diseases observed in 1931, not heretofore reported in Massachusetts.....	207
Unusual outbreaks of previously reported diseases.....	207
 The Cranberry Station:	
Injurious and beneficial insects affecting the cranberry.....	208
Cranberry photosynthesis studies.....	209
Weather observations.....	210
Pump tests.....	210
Cranberry varieties.....	210
Cultivated blueberries.....	210

Department of Dairy Industry:	
Factors affecting the aging time of ice cream mixes.....	211
The utilization of frozen fruits in ice cream and ices.....	211
A study of ice creams high in fat content.....	212
A study of the effect of various initial aging temperatures on the behavior of gelatin in ice cream.....	212
Department of Entomology:	
Investigation of materials which promise value in insect control.....	213
Control of onion thrips.....	215
The spray residue problem.....	216
Systematic study of oil sprays.....	216
Apple maggot control.....	217
Control of the plum curculio in apples.....	217
Biology and control of the carrot rust fly.....	218
Naphthalene and similar materials as fumigants for the control of greenhouse insect pests.....	219
Department of Farm Management:	
Enterprise relationships and farm organization on selected dairy farms in western Massachusetts.....	220
Types of farming in vegetable garden areas.....	220
A study of labor saving methods and technique on vegetable farms.....	220
Livestock management, methods, and costs.....	220
The cost of silage production in Massachusetts with special reference to the use of machinery.....	220
Feed Control Service:	
Feed control.....	221
Seed control.....	221
Dairy law.....	221
Advanced registry testing.....	222
Miscellaneous work.....	222
Fertilizer Control Service:	
Fertilizer inspection.....	222
Miscellaneous analytical work.....	223
Department of Floriculture:	
Study of the effect of plant nutrients on carnations and roses under glass.....	224
Breeding snapdragons for varietal improvement and disease resistance.....	224
Department of Home Economics:	
The comparative value of milk and tomato for supplementary feeding in elementary schools.....	225
The value of evaporated milk for school food service.....	225
Department of Horticultural Manufactures:	
Fruit juices and jelly making.....	225
Effect of microorganisms on the jellying power of fruit juices.....	226
Preservation and nutrition studies with cranberry products.....	226
Utilization of onions by canning and drying.....	226
Utilization of New England fruits in ice cream.....	227
Effect of freezing and thawing on microorganisms in foods.....	227
Research on dates.....	227
Vitamin content of Baldwin apples and other fruits.....	227
Canned rat baits.....	227
Department of Plant and Animal Chemistry:	
The effect of fertilizer and cultural treatment on the nitrogenous compounds of Ha- vana Seed tobacco.....	228
Tobacco field experiments.....	228
Oil Sprays.....	228
Nitrogen fixation in the presence of or as a result of the growth of legumes versus non-legumes under certain defined agronomic conditions.....	228
Chemical study of cranberries.....	229
Milk substitutes in the growing of young calves.....	230
Two systems of dairy cattle feeding—high roughage and low grain versus low roughage and high grain.....	230

Mineral requirements for the growth of dairy heifers.....	231
Studies in the chemistry of pasture grasses.....	231
Utilization of onions by canning.....	232
Department of Pomology:	
The interrelation of stock and scion in apples.....	233
Tree character of fruit varieties.....	234
The genetic composition of peaches.....	234
Testing methods of pruning.....	234
Effect of pruning bearing apple trees.....	234
Comparison of cultivation and sod in a bearing orchard.....	235
Comparison of clover sod and grass in a sod mulch orchard.....	235
Tests of different amounts of nitrate of soda.....	235
Comparison of cultivation and heavy mulching for apples and pears.....	235
The effect of fertilizer limitation on fruit plants.....	235
Role of potash and lime in fruit tree nutrition.....	236
Effect of potash and lime on apple trees.....	236
Study of varieties of tree fruits.....	236
Bud formation in the strawberry.....	237
Bud mutations.....	237
Light pruning of young grapevines.....	237
Storage of McIntosh apples under various conditions.....	238
Study of various spray materials.....	238
Blueberry culture.....	238
Cross pollination and sterility studies with certain apple varieties.....	238
Department of Poultry Husbandry:	
Broodiness in poultry.....	238
Breeding poultry for egg production.....	238
Statistical study of heredity in Rhode Island Reds.....	239
A genetic study of Rhode Island Red color.....	239
Determination of genetic laws governing results of inbreeding.....	239
Hereditary and environmental characteristics affecting variability in egg production.....	239
Factors affecting egg weight and shell character in domestic fowl.....	239
Relation of intensity or rate of laying to feather pigmentation.....	239
Department of Veterinary Science:	
Poultry disease elimination law.....	239
Pullorum disease investigations.....	240
Laboratory service—pathology.....	241
Farm and Station Bang's disease.....	241
Infectious laryngotracheitis.....	241
Moldy corn.....	242
Infectious bronchitis.....	242
Avian paralysis.....	242
The Waltham Field Station:	
The plant house.....	243
Electricity as a source of heat in the hotbed and propagating bench.....	243
Vegetable variety trials.....	243
Asparagus investigations.....	244
Seed improvement.....	245
Cooperative Tobacco Investigations:	
Black root-rot.....	245
Mosaic.....	246
Publications.....	247
Changes in staff.....	249

ANNUAL REPORT OF THE MASSACHUSETTS AGRICULTURAL EXPERIMENT STATION—1931

INTRODUCTION

F. J. Sievers, Director

The present economic conditions which are making themselves felt in a general industrial depression and consequent financial retrenchment, together with the maturing of the provisions under the Purnell Act, have provided little encouragement for the expansion of the service of the Experiment Station. Instead, certain readjustments of a more or less drastic nature were deemed necessary in the research program under way, and therefore several projects on which work has been in progress for a considerable period are being temporarily discontinued and the results prepared for publication. In other cases, through special efforts in promoting closer cooperation between departments, it has been possible to provide for the continuation of investigations that would otherwise have been prematurely terminated with the entire loss of previously expended energy and funds. Provisions for closer cooperation are especially effective in our relations with the United States Department of Agriculture through several of its Bureaus. In evidence of this are the projects in tobacco disease investigations, cranberry culture and bog management problems, corn borer control service, pasture management demonstrations and trials, and forage crop investigations, in all of which the relationships between the two agencies in question have been so satisfactory that there remained little to be desired.

While these developments in our program may not have made for the anticipated expansion so urgently requested by the loyal supporters of the Station, they, nevertheless, indicate progress of a desirable type. It is not unreasonable that, because of the tremendous changes in our entire economic structure, there should be equivalent readjustment in those research activities intended to exert a beneficial influence on industry. Agricultural experiment stations, as a result of their findings, have without question had a pronounced part in that increased efficiency which is considered partially responsible for the lack of proper balance in our entire industrial scheme. For a nation to be supplied to the point of superabundance in practically all commodities, and yet to be confronted with the extreme sociological and economical problems facing its population today, is the best evidence that we have not learned how to capitalize on the economic advantages at our disposal. The real solution of this tremendous problem requires research with a well-planned program of subsequent education; and our experiment stations, as organized, may well consider that they have a responsibility in this field.

Certainly with the continued increase in the application of science to all industry, and especially to agriculture, there will be a consequent need for regulation of employment to offset the lesser demand for labor resulting from the greater efficiency in its producing power per unit of time. This should also express itself in a demand for a constructive and more wholesome program of recreation to furnish an outlet for the proper utilization of increasing amounts of spare time and unemployed energy, if we are to capitalize fully on the real profits from

industry. The trend in this direction is already indicated in the demands especially expressed to us for research in the fields of floriculture, golf course management, landscape gardening, and in the culture of ornamental plants. In floriculture, golf course management, and landscape gardening the Massachusetts Station has already made sufficient progress in its investigations to show not only that scientific methods have a place in these fields, but that the results found are worthy of practical introduction and therefore are appreciated. Since New England in general, and Massachusetts in particular, is favored because of natural beauty and is rapidly becoming recognized by tourists and summer vacationists as one of the playgrounds of America, it may not be inconsistent to extend increased consideration to a program of research wherein this asset can be capitalized for purposes of promoting the recreational and the aesthetic. At any rate we shall be confronted with an increasing demand for service in this field as time goes on.

DEPARTMENT OF AGRICULTURAL ECONOMICS

Alexander E. Cance in Charge

The Economic Worth to Growers of Different Varieties of Apples. (Lorian P. Jefferson). This project, begun at the request of the Pomology Department, should be completed in 1932. At least one member of the Pomology Department is of the opinion that such a study would be of greatest value if continued for ten years. It has, however, been increasingly difficult to get from the growers consecutive annual figures for their orchards. One or two of the orchardists who gave reports for the first years of the study, met with untoward events, and their orchards could not be included the following year. One or two others gave figures one year, but because of lack of interest, did not wish to give them thereafter. The number of orchards from which reports are now available is much smaller than at first.

Consumer Demand for Eggs. (Lorian P. Jefferson). The field work on this project has been completed and much of the tabulation. Some few sections of the report are in the first draft.

Changing Methods of Wholesale Distribution of Perishables. (Lorian P. Jefferson). It is the general opinion of dealers that the great factors in bringing current changes in the wholesale marketing of perishables are the traveling jobber and the chain store. The work done on this project has been thus far confined largely to a study of the place of the traveling jobber in the marketing of fruits and vegetables.

The traveling jobber has been known in some markets for 10 or 15 years, but in the main he is a newcomer. The business requires little capital, just enough to get possession of a truck and perhaps pay for the first load of produce. Two classes of these jobbers are found: (1) The one does a legitimate business, performing a real service to the retailer with whom he deals. He buys as good products as the retailer desires and distributes them regularly over a regular route. He is a reliable customer of the wholesaler. Occasionally he buys also from the producer. (2) The other buys on a glutted market or when he can see a chance to make a profit. In general neither the wholesaler nor the retailer likes him. The wholesaler will not extend credit to this class, and many of the retailers report that they do not buy from them.

The chain store apparently has had no easy path in distributing perishables, a line which was not handled until comparatively recently. Their stores were not fitted to house fruits and vegetables, nor had they buyers or clerks who were acquainted with these products. This has apparently meant loss in handling perishables, and it is reasonable that this should cause much concern among chain store officials.

The development of the terminal market is another factor in current market changes. Some attention has been given to the South Boston Market Terminal. Statistics have been secured regarding the volume of various products handled there since the opening in 1927. Other material is available for the further study of the influence of this market.

Analysis of Market Prices for Massachusetts Vegetables. (H. B. Rowe.) The price and supply series used as the basis for this study have been extended to cover a ten-year period. More complete and precise analysis of the data, along the lines previously reported, has made possible the measurement of certain important trends and seasonal tendencies, as well as approximate statements of the relationships between local vegetable prices and such important price determinants as local supply, shipped-in supply, price level and business activity.

Recreational and Forestry Uses of Land. (David Rozman.) The field work in connection with this project has now been completed and the material is being prepared for publication.

This study analyzes the present condition of abandoned farm land areas in Massachusetts and makes recommendations for the policies to be pursued in bringing about a balanced program of land utilization in the Commonwealth.

Housing Conditions and Problems in Part-Time Farming. (David Rozman.) During last summer an investigation was made of housing conditions and problems in part-time farming in Massachusetts and other New England states. The results of this investigation, together with recommendations, were presented in a report for the President's Conference on Home Building and Home Ownership.

Factors Affecting the Price of Eggs. (A. H. Lindsey.) The small amount of time allowed for this project was expended on increasing the accuracy of outlook reports. Correlation between prices of eggs and meat prices indicates very little relationship. Storage margins have very little effect on the amount of eggs stored the following year.

The Relation of Quality Factors to Price of Eggs. (A. H. Lindsey.) Work on this project is now completed and it is in manuscript form. The tabular analysis has been made during the last year with the following results:

Weight, as in the correlation analysis, varied directly as the price; quality varied with price through most price ranges, but premium prices did not insure best quality; the average quality of eastern eggs was invariably better than the average quality of western eggs. Price of storage eggs showed very little relationship to quality, but weight was directly related to price. The fact that eggs were branded or labeled did not guarantee uniform quality.

Correlations were run between the external factors, as number of dirty eggs, uniformity of color, uniformity of size, and price. The range in weight of eggs within the dozen had no apparent influence on price. The number of eggs off color reduced the price per dozen from $\frac{1}{4}$ to $\frac{1}{2}$ cent per off-color egg. The reduction in price per dozen for each dirty egg was about $\frac{1}{2}$ cent.

Competitive Factors Influencing the Supply of Market Milk and Cream. (A. H. Lindsey). Lack of time prevented additional work on this project, except for a survey of the Springfield milk market.

DEPARTMENT OF AGRICULTURAL ENGINEERING

C. I. Gunness in Charge

Investigation of Apple Storages. (C. I. Gunness). The study of apple storage carried on in cooperation with the Department of Pomology indicates that McIntosh apples can be stored at a temperature somewhat higher than 32° for a short time after harvest, if they are subsequently cooled to 32° for the balance of the storage season. A system of management whereby apples are kept at a temperature ranging from 40° to 45° during the first week after picking, with the temperature gradually reduced to 32° by the middle of October, results in no appreciable shortening of the safe storage season. This management permits a considerable saving in the cooling equipment required.

A study of the use of blowers as compared with wall coils indicated no tendency for the air blast to dry out the fruit during the 1930-31 season. This study is being continued during the present storage season.

In order to study the effect of humidity on the storage of apples, three cabinets were installed this season in three storage rooms maintained at different temperatures. Each of the cabinets has three chambers in which apples are stored. One chamber in each cabinet is maintained at a relative humidity of 65 per cent, one at 75 per cent, and one at 90 per cent. It is too early to comment on the outcome of this study.

Fertilizer Distributors. (C. I. Gunness). A device has been perfected for applying liquid fertilizers to golf greens or lawns where water under pressure is available. By this arrangement a relatively heavy application of fertilizer can be made without danger of burning, as the fertilizer solution is diluted by the water spray and evenly distributed.

Test of Low-lift Pumps. (C. I. Gunness). Two pumps were tested at the Cranberry Station at East Wareham during the summer. The tests indicate that where electric power is used, the self-contained pumping unit has a higher efficiency than can be obtained through the use of the large low-speed pumps which are commonly used on cranberry bogs.

DEPARTMENT OF AGRONOMY

A. B. Beaumont in Charge

Pasture Experiments. (A. B. Beaumont and E. F. Gaskill). The top-dressing of certain areas on the Tillson and Hobart farms and on ten farms in Worcester County was continued in 1931 with results quite similar to those of preceding years. Considerable evidence has now been accumulated which shows that run-out upland pastures of Massachusetts are deficient in calcium, phosphorus, potassium, and nitrogen.

Further evidence was obtained of the toxicity of nitrate of soda for a moss (*Polytrichum commune*), common to run-out, upland pastures of New England. Both the Chilean and the synthetic nitrate of soda exerted this toxicity, but it was not shown by several other commonly used nitrogen fertilizers.

Additional evidence of the superior palatability of timothy as a pasutre grass was secured. Holstein cows did not discriminate between timothy, Kentucky blue grass and redtop in the early stages of growth; but from the time the grasses were four inches or more high, the preference was first, timothy; second, redtop; third, Kentucky blue grass.

In cooperation with the Department of Animal Husbandry, a test was made of the Jerusalem artichoke as a midsummer and late summer pasture crop for dairy cattle. It was found that the crop furnished pasturage comparable in amount to that supplied by the temporary crops, oats, Sudan grass and Japanese millet. Most of the animals used in the experiment were slow in becoming accustomed to the new crop, though some ate it very readily.

Legume Variety Tests. (Wm. L. Jones and A. B. Beaumont in cooperation with E. A. Hollowell, Bureau of Plant Industry, U. S. D. A.).

Alfalfa. In the 1929 seeding, Argentine yielded the highest (4.92 tons in 2 cuttings), followed by Kansas, Hardigan, Nebraska, Ontario, Dakota Common, Disco, Utah, Italian, Hungary, Dakota 12, Arizona, South African, New Mexico, Ladak, Turkestan, Hairy Peruvian (3.20 tons). The field was covered with snow from the middle of December, 1930, till the first of March, 1931, which probably accounts for the good showing made by some of the southern strains. In the 1930 seeding, the yields were uniformly high, the order being: Dakota Common, Hardigan, Italian, South African, California, Ladak, New Mexico, Grimm, Hungarian, Argentine, Kansas, Oklahoma, Turkestan.

Red Clover. Eighteen American and European strains of red clover were tested. Owing to heavy August rains it was possible to make only one cutting, and that was fairly heavy for all strains. In general, American strains outyielded European strains and maintained the stand better through the season.

Vetch. Five varieties seeded in August, 1930, were so weedy in the spring of 1931 that it was not considered worth while to obtain yield data. Stand was best for Wooly Pod and Hairy, intermediate for Oregon Hairy and Oregon Common, and poorest for Hungarian. In the spring seeding of 1931, highest yield of hay was obtained from Oregon Pearl (1.44 tons per acre), followed in order by Hairy (15760), Oregon Common, Hungarian, and Smooth (15851) (1.04 tons). Experience thus far indicates that neither spring nor winter vetches are promising for this section.

Sweet Clover. In the experiment on date of seeding hulled (scarified) and unhulled sweet clover, best stands were obtained from seed sown in early December and January. In seedings made from February to May the stand decreased with advance of the seeding date, that is, the May seeding gave the poorest stand. There was no essential difference between the hulled and unhulled seed. All seedings were made on the surface of plowed and harrowed soil or on the snow covering.

Field Peas. Chang again yielded the most hay, followed in order by Golden Vine, Multiplier, Wisconsin Common, and O. A. C. 181; but owing to a bad infestation of aphids, the yield of each variety was less than 1 ton per acre.

Soy Beans. Of 20 varieties of soy beans, the following 10 yielded the most hay in decreasing order: Dunfield (3.04 tons), Chestnut, Habaro, Black Eyebrow, Medium Green, Harbinsoy, Pinpu, Mansoy, Soysota, Ito San (2.54 tons). Of these, Dunfield, Habaro, Medium Green, and Harbinsoy have been among the highest yielding 10 varieties for the past three years, Dunfield always leading.

Field Experiments with Onions. (M. E. Snell and A. B. Beaumont).

Fertilizer Ratios. Except for a few changes the fertilizer and lime experiments with onions were conducted as they were last year. One ton of lime per acre was applied to the south half of all plots, making possible a comparison between three 1-ton and one 2-ton applications over a period of seven years. Nine of the former cover-crop check plots, used last year for 6-8-8 plots, were changed over to 2-12-8 and 6-12-8 plots. (Figures refer to percentage of NH_3 , P_2O_5 , and K_2O .) The 4-12-8 organic gave appreciably higher yields this year, followed in order by the 4-12-4, 6-8-4, 4-7-4 (2-1-0 first top-dressing), 4-8-4 (nitrate top-dressing), and 8-16-8. The 2-12-8, 4-8-8, 6-8-8, and the 4-12-8 inorganic were all inferior to their adjacent checks. The three 1-ton applications of lime gave higher yields than one 2-ton application in almost every treatment. One ton of lime, applied to the plots of the old lime series which had had heavy applications in 1925, had a depressing effect on yield. Extra applications of superphosphate alone or with lime increased the yield, but of the two the lime seemed to be the more effective.

Size of Sets. Following the line of work started last year, a comparison was made of commercially graded sets ranging from $\frac{3}{8}$ to $\frac{1}{8}$ inch with specially graded sets ranging from $\frac{1}{2}$ to $\frac{3}{4}$ inch, to determine whether the range in size of set could be broadened to include more sets without lowering their value for planting. It was found that the commercially graded sets produced a larger percentage of split bulbs and seed stalks as well as a greater variation in size of bulb. After all bulbs which were small, divided, or had seed stalks were deducted from both grades, it was found that the specially graded sets produced slightly more bags per acre than the commercially graded sets.

Growing Onion Sets. An experiment conducted last year showed quite conclusively that a medium-sized set was far more desirable for planting than either small or large sets. This made it desirable to know how to grow sets which would give a maximum number of the medium-sized sets. Accordingly an experiment was planned having two fertilizer levels, two widths of rows, and three rates of seeding. Best results were produced by 50 pounds of seed and 500 pounds of fertilizer per acre and 2-inch rows.

Onion Breeding. (M. E. Snell). This project has been developing gradually and expanding along the lines adopted at the beginning. Of the 80 strains and varieties tried, 36 have been discarded as inferior. The past season 992 bulbs which were selections from 142 of the better groups selected from the 1344 lots of bulbs grown in 1930, were planted for seed production. These bulbs represented 31 of the remaining 44 strains. Of the 142 groups planted for seed production, 13 were used in some crosses which were started this year. Vegetable parchment paper bags were very successfully used for covering the self-fertilized heads in place of the cheesecloth coverings formerly used. The paper bags should be much more effective in preventing cross fertilization and seemed to give flowers and seeds better protection from unfavorable weather. The past season 284 lots of bulbs representing 14 of the original strains were produced from seed, 165 of them from self-fertilized seed and 118 from mass-fertilized seed. It has been observed that within groups there is a marked tendency toward uniformity of characters in the growing seedlings, the grown bulb, and the second-year plants. Some of the more outstanding characteristics are: color of leaves, coarseness of leaves, and early dormancy in the seedlings; firmness, shape, skin texture, and keeping quality in the bulbs; length of seed stalk, earliness of bloom, production of viable seed, and number of seed heads per bulb in the second-year growth.

Field Experiments with Tobacco. (A. B. Beaumont and M. E. Snell). Yields of tobacco in the field experiments were above average in 1931, but not quite so good as in 1930.

Cropping Systems. The highest yield (1816 pounds cured tobacco per acre) was obtained from plots which received a full ration (3500 lbs.) of commercial fertilizer (4.1% N, 4% P_2O_5 , 5% K_2O) and had a cover crop of redtop the previous winter. Rye and timothy also, as cover crops, were beneficial but not to the same degree as redtop. Three-fourths ration of commercial fertilizer supplemented by 10 tons manure produced more tobacco than fertilizer alone, and about the same as a full ration of fertilizer with cover crops. A cover crop of timothy had a slight depressing effect on the results from manure and fertilizer. Low yields of tobacco were again obtained in the animal husbandry rotation (corn, timothy or clover, and tobacco). The yield of tobacco in this rotation was somewhat better after clover than after timothy, but following both crops only about two-thirds that of tobacco grown in continuous culture.

Different Quantities of Nitrogen. The highest yield (2025 lbs.) was obtained with 205.6 pounds nitrogen per acre, followed by 1953 pounds tobacco from 164.5 pounds nitrogen, 1727 from 123.4 and 1513 from 61.7. These figures are more in accordance with the mean of the past several years than were those of last year.

Different Carriers of Nitrogen. Where tobacco was preceded by timothy sod two years ago, the largest yield was obtained with ammonium sulfate, followed by sodium nitrate, cottonseed meal, and the standard mixture. Where timothy sod immediately preceded tobacco, the order of production was urea, ammonium sulfate, sodium nitrate, standard mixture, and cottonseed meal; but all these yields were only about three-fourths those from plots having corresponding treatments, but two years removed from timothy sod. Urea was introduced in this experiment for the first time this year and only on plots immediately following sod.

Method of Applying Fertilizer. A full ration applied in the row caused some stunting of plants, but in the end produced more tobacco (1996 lbs.) than the same amount applied broadcast (1906 lbs.); three-fourths ration in the row produced slightly less (1883 lbs.) than the full ration broadcast (1906 lbs.); and one-half ration in the row produced considerably less (1677 lbs.) than the full ration broadcast (1991 lbs.).

Miscellaneous. Milorganite, an organic fertilizer made from processed sewage, again proved a good substitute for cottonseed meal for tobacco, producing 1911 pounds cured tobacco. The quality of last year's crop from this material was slightly below that from cottonseed meal.

When ground tobacco stems were substituted for potassium salts as the carrier of potash in the standard fertilizer mixture, the yield of tobacco was 1459 pounds, while that from the standard mixture was 1689 pounds.

Nitrogen Metabolism in the Tobacco Plant. (W. S. Eisenmenger.) Tobacco plants grown in nutrient salt solutions were analyzed for total nitrogen and for the following nitrogen fractions: ammonia, nitrates, alpha amino acids, amides, water soluble albumen, proteose, and humin. Relatively large amounts of inorganic nitrogen were found in the plants. The plant parts arbitrarily chosen for analysis were roots, stems, midvein of leaves, and the residual part of leaf after midrib was removed. Although no categorical statement can be made as to the exact location of reduction of nitrate nitrogen in the plant, inferential evidence from the analyses would indicate that this process takes place at or near the midvein of the leaf.

Magnesium Requirements of Crops. (A. B. Beaumont and M. E. Snell)

In a field experiment, corn, potatoes, timothy, alsike clover, soy beans, and onions were grown on soil known to be deficient in magnesium. Only corn showed distinct symptoms of magnesium deficiency by chlorosis of the leaves. There were some indications of chlorosis on soy beans and alsike clover, but they were not positive. However, with all crops except timothy, yields were better where magnesium sulfate was applied in recent years than where magnesium sulfate was not applied. Magnesium-deficient soils taken from the field in 1929 were used to grow corn, potatoes, timothy, alfalfa, red and alsike clover in pots. Here, also, only corn exhibited positive symptoms of magnesium deficiency.

Method of Applying Fertilizer to Corn. (A. B. Beaumont, E. F. Gaskill and R. W. Donaldson.) For the fourth consecutive year this test has been continued according to the standard plan prepared by the Joint Committee mentioned in the last annual report. Again it has been demonstrated that, under our conditions, a small amount of mixed fertilizer (4-10-6 grade) is more effective for corn when placed in the hill than when broadcast. Both the 125-pound and 250-pound applications in the hill produced more and better ears of corn than did 500 pounds broadcast. The exact placement of the fertilizer with reference to the seed made no difference so long as it was in the hill and near, but not in contact with, the seed.

Fertilizer Ratios for Grassland. (A. B. Beaumont and M. E. Snell). In 1928 an experiment in the top-dressing of an old mowing (meadow) was started. A mixed fertilizer with a varying ratio of nitrogen, phosphoric acid and potash has been used. Comparisons have been made by maintaining two of the nutrients at a constant level and varying the third. Data accumulated through four years show a distinct response to increments of nitrogen, a slight response to increments of potash, and no response to increments of phosphoric acid.

Nitrogen in Golf Green Clippings. (M. H. Cubbon). In 1928, clippings from greens in the vicinity of Amherst contained slightly less than 3 per cent nitrogen (dry matter basis) the first week in May. By the first of June the nitrogen content was 5 per cent. This general level was maintained until the latter part of August, with pronounced reduction after September 1. The highest individual percentage found was 5.92. Growing conditions were favorable throughout the season. No increase in nitrogen was found following application of nitrogen fertilizers.

Lawns and Lawn Grasses and Management. (L. S. Dickinson). Extensive studies have been made as to the desirability of pre-seeding fertilization of newly built lawns or other turf areas. The object of the studies was to obtain further data concerning the effect upon the balance between root growth and leaf of grasses when fertilizer is applied before seeding. Nitrogen, phosphorus, and potash were applied singly and in various combinations, and the grasses grown were Kentucky blue grass and Colonial bent. The results indicate that on normal soils pre-seeding fertilization with anything but superphosphate or a strictly phosphorus carrier is unnecessary and even undesirable if a well-balanced grass plant is desired. The project was made possible by the New England Greenkeepers' Association.

Additional data have been obtained regarding the influence of certain fertilizers and grasses on the control of angleworms in putting green turf.

The plots maintained in cooperation with the United States Golf Association continue to furnish interesting data, and the value of complete fertilizers with high nitrogen content is very obvious on the closely clipped putting green turf.

On the eight-year campus lawn plots with Kentucky blue grass, cottonseed meal continues to produce such a healthy stand of grass that weeds find no room.

DEPARTMENT OF BACTERIOLOGY

Leon A. Bradley in Charge

Nitrogen Fixation in the Presence of or as a Result of Legumes versus Non-Legumes. (J. E. Fuller). Nitrogen fixation studies comparable with those previously published (L. A. Bradley and J. E. Fuller, *Soil Sci.* 30: 49-57, 1930) were made. Samples were taken from the various sections of the experimental plot in the spring (1931) before the crop was planted, and in the fall after the crop was harvested. Nitrogen fixation at both seasons appeared to be reasonably constant and generally distributed over the plot. There was no significant difference noted between the legume and non-legume strips. This agrees with findings of 1926 and 1928, reported in the publication mentioned above. In order to estimate the quantitative distribution of nitrogen-fixing microorganisms through the plot, studies were made of the various soil samples by a dilution method. The dilutions employed were 1 in 100, 1 in 1000, and 1 in 10,000, and 1-cc. quantities were inoculated in Ashby's solution. In soil samples taken in the spring there was no nitrogen fixation from any except the 1 in 100 dilution. The samples taken in the fall gave definite nitrogen fixation from all dilutions, indicating an increase in the number of the nitrogen-fixing microorganisms during the season. There was no difference between the legume and non-legume strips.

The activity of the soil in nitrifying dried blood and ammonium sulfate, and in decomposing cellulose, was studied. Both functions were active and generally distributed over the whole field. There was no difference between the legume and non-legume strips. These studies were made on the soils collected in the spring. Studies on the samples collected in the fall have not been completed.

The fertilizer treatment of the plot, and the crop planted on it, are reported under the same title as that above by the Department of Plant and Animal Chemistry (F. W. Morse).

Utilization of Mannite by Azotobacter. (J. E. Fuller.) The practice of reporting the amount of nitrogen fixed by bacteria as milligrams of nitrogen per gram of consumed mannite appears to be faulty. The mannite rarely is entirely consumed; and in 100 cc. quantities or less of culture media, it is impractical to estimate the amount of residual mannite. Experiments showed that soil inoculum and pure cultures of *Azotobacter*, each supplied with 10-gram quantities of mannite, fixed only slightly more than twice as much nitrogen as was fixed when 2-gram quantities of mannite were supplied.

Influence of Temperature on the Nitrate Content of Soil in the Presence of Decomposing Cellulose. (J. E. Fuller and L. H. Jones.) Compost soil with one per cent added cellulose (filter paper) was incubated for 6 weeks at temperatures of from 10° C. to 35° C., at intervals of two and three degrees. Nitrate tests were made each week. At temperatures of 25° to 35° there seemed to be sufficient nitrification to replace the nitrate loss in the presence

of cellulose. A nitrogen-poor soil with one per cent added cellulose (wheat straw) was treated in the same way as the compost soil. At all temperatures there was loss of nitrates in the presence of cellulose. Sodium nitrate, calcium carbonate, and calcium sulfate added to the soil separately and in combination at temperatures of 15° C., 25° C., and 35° C., did not prevent nitrate depletion in soil to which cellulose had been added. The loss of nitrate appeared to be greater when the calcium carbonate alone was added to the soil.

Laboratory Service. (Ralph L. France.) A total of 1,248 examinations was made in this laboratory during the past year. Briefly summarized they may be classified as follows:

Bacterial counts of milk.....	1,033
Sanitary analysis of water.....	149
Miscellaneous.....	66

Under miscellaneous are included examination of milk for garget or other abnormal udder conditions, examination of various food products for organisms causing spoilage, and chemical analysis of milk.

The total number of bacterial examinations of milk has increased materially over previous years. This is a clear indication not only that the laboratory is providing valuable service to the milk control program of the Valley, but also that dealers and producers now realize that a clean, wholesome product influences purchase by the consumer.

The total number of legume cultures distributed during the year has decreased considerably. In all probability this is due to the statewide distribution of cultures prepared by commercial concerns under the supervision and control of the United States Department of Agriculture.

The Indol Tolerance of the Colon-Aerogenes Group of Bacteria as a Possible Means of Differentiating Fecal and Non-Fecal Strains Occurring in Drinking-Water Supplies. (Ralph L. France.) The preliminary work on this project has been completed and the data are being assembled for publication. The results indicate that the methods for sanitary water analysis now employed in the majority of laboratories may lead to inaccurate interpretation of experimental results. Experimental evidence seems to indicate the necessity of submitting Colon bacilli found in water to various biochemical tests for the differentiation of fecal and non-fecal types of this organism rather than placing an interpretation of sanitary quality upon the routine Endo plate and lactose broth fermentation. A discrepancy of 40 per cent was found to exist between these two confirmation methods. The writer now proposes to submit these fecal and non-fecal strains of the Colon bacillus to various dilutions of indol in an effort to determine a possible difference in the indol tolerance of the organisms.

DEPARTMENT OF BOTANY

A. Vincent Osmun in Charge

Tobacco Black Root-Rot. (W. L. Doran). Loss in yield of tobacco in plots last limed in 1923 is decreasing. The decrease in yield caused by black root-rot in these plots is now only about 16 per cent, or one-third of what it was in 1925. But the soil in these limed plots has not yet become any more acid.

An application of sulfur (500 pounds per acre) to a field, the soil of which had an initial pH of 6.4, lowered the pH value to 6.1, but this was insufficient to prevent infection of tobacco by *Thielavia*, and growth of plants was not affected. Yields of tobacco have been increased consistently when sulfur has been applied to a soil infested with *Thielavia* if the pH value of this soil was lowered by the sulfur to below 5.9, but not otherwise.

Liming was without any effect on the fire-holding capacity of the tobacco grown in 1929. In the case of the crop of 1930, the burn of the darks was improved, but the burn of the seconds was not affected by lime. Sulfur (400 pounds per acre) did not reduce the fire-holding capacity of the leaf grown in 1930. Burn of the darks was better in plots in which tobacco was grown every year than in plots in which tobacco followed timothy or alfalfa.

In 1930, the quality of tobacco grown in limed plots was as good as that in plots not limed. In earlier years, both yield and quality of tobacco have been lower in limed plots.

In pot experiments, soil pH values were not significantly lowered by aluminum phosphate alone, and they were lowered as much by sulfur alone as by sulfur with aluminum phosphate. When these treatments were applied to soil infested with *Thielavia basicola*, the severity of black root-rot was reduced and growth increased as much by sulfur alone as by sulfur and aluminum phosphate together.

Brown Root-Rot of Tobacco. (W. L. Doran). With the cooperation of H. D. Haskins, it was found that soils in which brown root-rot was most severe were characterized by high water-holding capacity, high content of clay and silt, and low content of sand. Soils in which brown root-rot was mild or from which it was absent, were characterized by high content of sand, low water-holding capacity, and low content of clay and silt. No consistent relation was found between the severity of brown root-rot and pH value of soil, soil content of organic and volatile matter, total nitrogen, nitrate nitrogen, or iron and aluminum oxides soluble in water.

The effects of ammonium thiocyanate on brown root-rot and growth of tobacco are being investigated.

Onion Diseases and the Use of Fungicides on Onions. (W. L. Doran). As in earlier years, this work was done in cooperation with A. I. Bourne. There was no downy mildew, but blast was severe in 1931, appearing, as in 1927 and 1928, about the third week of July.

The onset of blast was delayed, but not prevented, by spraying with Bordeaux mixture. Yields were increased somewhat, however, in all plots sprayed 4 times with Bordeaux mixture. As in the previous three years, copper-lime dust was of no benefit.

Growers who find the ownership of a power sprayer feasible, and who spray onions with nicotine sulfate for thrips, may, on the basis of the results of these experiments, expect some further increase in yield if Bordeaux mixture is used with nicotine sulfate; but there is no evidence that the purchase and use of a power sprayer solely for the application of Bordeaux mixture to onions would be profitable in the average year in Massachusetts.

A report of this work has been published in Bulletin 279.

Downy Mildew of Cucumbers. (W. L. Doran). In each of the six years ending in 1930, this disease has always occurred in Massachusetts; but it was not found in 1931, although many fields of cucumbers were examined at weekly

intervals until the plants were killed by frost. The occurrence of the disease here seems to have no relation to summer rainfall. Lack of primary infection rather than failure of the disease to spread would seem to explain its absence.

There is no positive evidence that the causal fungus, *Peronoplasmopara cubensis*, ever lives through the winter in Massachusetts. (It is usually present in greenhouses here in the fall and early winter, but has never been seen by the writer on the spring greenhouse crop.) This year, as in earlier years, oospores and other wintering-over stages were looked for, both in green leaves and in leaves killed by the disease and wintered in the soil outdoors, but none were found. As before, no infection resulted from the inoculation of cucumbers with inoculum consisting of cucumber leaves killed by downy mildew and buried in the soil in the field during the winter.

It has often been suggested that the fungus, wintering-over in Florida, may move northward with the crop and the advance of the season each spring and summer. In 1931, downy mildew was much less severe than usual south of here, notably so in Florida, Georgia, West Virginia, Delaware, and Connecticut. It was present as usual in Connecticut in 1930, but only a trace of it was found in that State in 1931, and that not until about two months after its usual date of appearance in the Connecticut Valley. There was, therefore, a minimum chance of the fungus reaching Massachusetts from states further south.

Acetic Acid and Pyroligneous Acid as Soil Disinfectants. (W. L. Doran). Damping-off was prevented, without injury to germination and with benefit to growth, by soil treatment with acetic acid 1.2 per cent, 2 quarts per square foot, 10 days before seeding. The cost, for a unit area of soil, was three-fourths that with formaldehyde. Damping-off was prevented, with no injury to germination, by vinegar 1 part diluted with $2\frac{1}{2}$ parts of water (by volume) applied at the rate of 2 quarts per square foot 10 days before seeding. Seedlings of red pine were protected against damping-off, and germination was not injured, by acetic acid 0.8 per cent applied to soil at the rate of $\frac{3}{4}$ quarts per square foot at the time of seeding.

Pyroligneous acid, 4 parts diluted with water to a total of 100 parts (by volume), applied to soil at the rate of 2 quarts per square foot, protected seedlings against damping-off and did not injure seed germination even when applied to soil as late as 1 day before seeding. Per unit area of soil treated, the cost of pyroligneous acid was about 58 per cent of the cost of formaldehyde. The effect of pyroligneous acid on onion smut is now being investigated.

Eggplant Wilt. (E. F. Guba, Waltham). Study of the lower limit of tolerance of eggplant and its *Verticillium* pathogene to pH values has been continued. Inhibitory effect on growth of eggplant occurred from aluminum sulfate at pH 4.4-4.6, and from inoculated sulfur at pH 3.8-4.0. With aluminum sulfate there was good control of *Verticillium* at pH values between 4.5 and 5.0, but no control above pH 5.0; with inoculated sulfur there was some control at pH values between 3.8 and 4.8, but no control above pH 4.8. These results are in agreement with those offered in the previous report, and show that the lower limits of tolerance of eggplant and its *Verticillium* pathogene to pH values are too close to allow the practical use of sulfur or aluminum sulfate for obtaining the desired range of pH in which control, or partial control, of the disease could be expected.

In field experiments, an application of one ton of inoculated sulfur per acre lowered the reaction of the soil from pH 6.8 to 6.2. Aluminum sulfate at the same rate of application lowered the reaction to pH 6.4. No control of wilt was obtained

in either case. Other sulfur plots, continued from the previous season, gave satisfactory control of wilt and also retarded growth of the plants, indicating the difficulty attending artificial soil acidification. No further work on this project is contemplated.

Strawberry Gold Disease. (E. F. Guba, Waltham). Seed from strawberry plants affected with gold disease produced both diseased and disease-free seedlings, indicating seed transmission of the disease. Marked stunting and necrosis was associated with seedlings exhibiting this trouble. Experiments show that all the vegetative progeny of "gold" plants acquire the disease. Strawberry beds started with plants from beds free of gold disease remained free; but when new beds were propagated with plants free of the symptoms of the disease but from a source in which the disease was present, its prevalence in the new bed was not reduced. The selection of disease-free plants from a gold-disease source for starting new beds, with subsequent roguing of all plants showing symptoms of the trouble, failed to control the disease. Aside from the systemic nature of this disease, no evidence has been obtained to show the manner of spread.

Control of Greenhouse Vegetable Diseases. (E. F. Guba, Waltham).

Tomato leaf-mold. Efforts to control this disease by automatic adjustment of air conditions have been continued. In the fall-winter of 1930-31, 28.6 per cent less leaves infected with leaf-mold resulted with automatic humidity control (relative humidity 80-85 per cent and temperature 60°-73°F.), than with automatic temperature control (temperature 60°-65° F.), and the average total yield of tomatoes per plant with automatic humidity control was 1.09 pounds less than with automatic temperature control.

In the spring of 1931, operation of controls was discontinued after May 15 and thereafter all available ventilation was provided. Leaf-mold did not appear until June and eventually all foliage became infected, although the yield was not influenced. The total average yield of tomatoes per plant was 1.64 pounds less with automatic humidity control than with automatic temperature control.

A smaller amount of infected foliage and a lower yield have been associated with automatic humidity control, while under automatic temperature control and with careful management the prevalence of leaf-mold has never been great enough to reduce the yield. The reductions in yield associated with automatic humidity control appeared to be due indirectly to the higher temperatures needed to effect the desired control of the relative humidity of the greenhouse air.

A study of the relation of temperature to spore germination and growth of germ tubes is in progress.

A study of the reaction of a large number of tomato varieties to *Cladosporium fulvum* Cke. shows differences in the susceptibility. Further work is in progress to determine the feasibility of hybridizing desirable market types with types resistant to leaf-mold.

A manuscript dealing with the temperature and humidity relations of the causal organism and the relation of greenhouse air management to control of leaf-mold is being prepared.

Effect on plants of hydrocyanic acid gas after treatment with copper sprays. This work is being done in cooperation with Dr. E. B. Holland of the Chemistry Department.

Cucumber plants were never injured when fumigation with hydrocyanic acid gas followed spraying with Corona Copper Carbonate (18 per cent and 50 per cent active Cu) or Holland's Basic Copper Sulfate (26 per cent and 53 per

cent active Cu). These diluted sprays are neutral to litmus. On adding calcium hydroxide, injury followed gas and increased proportionately with the alkali present. Acid copper fungicides, i.e., normal and basic copper acetate, Bordeaux 1-0.20 and 1-0.22, Burgundy mixture 1:0.3 and caustic soda Bordeaux 1:0.2 followed by gas caused severe injury. Copper sulfate solutions .05 per cent and .07 per cent with gas were not injurious.

When gas followed spraying of cucumber plants with copper fungicides containing calcium hydroxide, sodium hydroxide, or sodium carbonate, injury always resulted. Even when the alkali component was reduced to make a mixture neutral to litmus, injury resulted after gas.

Injury occurred regardless of whether hydrocyanic acid gas was evolved from calcium cyanide or from sodium cyanide and sulfuric acid, and of whether chemical hydrated lime or milk of lime was used in the preparation of Bordeaux mixtures. The injured leaves always gave soluble copper, and the amount of copper and the degree of injury increased approximately with the alkali present in the fungicide.

Carbon bisulfide emulsion treatment for nematode-infested soil. Excellent results were obtained with both commercially prepared and homemade carbon bisulfide emulsions applied to nematode-infested soil. In bushel boxes, soil treated with the commercial product produced tomatoes with gall-free roots. In pots, a homemade emulsion gave clean roots in all but one instance. In both series of tests, the control plants were heavily infested. Repeated tests with homemade emulsion in badly infested commercial greenhouses gave satisfactory results.

Carnation Blight. (E. F. Guba, Waltham). A more complete list of varieties of carnations showing their reaction to the causal organism (*Alternaria dianthi* S. & Hall) has been prepared as a result of further study.

The optimum temperature for growth of the organism in pure culture is approximately 80° F.; the minimum and maximum limits are approximately 39° and 97° F., respectively.

Salt 5 per cent and nicotine sulfate 0.2 per cent, combined in solution and used for combating red spider, were not toxic to the conidia of *Alternaria* and did not in artificial inoculation experiments provide satisfactory protection against infection of potted plants. Salt solution possessed some fungicidal value, but nicotine sulfate none.

Potassium permanganate 1-1000 strength proved a valuable disinfectant for carnation cuttings. A 5-minute dip greatly improved rooting and provided rather good disinfection of *Alternaria* inoculum accompanying the cuttings.

Further experiments confirm the superiority of naphthalene fumigation in controlling *Alternaria* blight and *Fusarium* stem-rot as compared to water syringe. A difference of 35.1 per cent in yield of No. 1 blooms in favor of naphthalene fumigation was obtained.

Bordeaux 4-4-50 to which was added 1 pound of calcium arsenate, the same with the addition of $\frac{1}{2}$ pint of fish oil, and Bordeaux 4-4-50 plus $\frac{1}{2}$ pint of fish oil, were the most efficient treatments in the field, their relative efficiency being in the order given. A proprietary copper mixture, sulfur fungicides, and dusting materials containing sulfur, calcium arsenate, monohydrated copper sulfate, naphthalene, and lime gave no control of the disease.

Experiments show that outdoor planting, propagation before January, benching after July 10, and drip from leaks in the greenhouse greatly increase the hazard from *Alternaria* blight.

Monograph of the Genus *Pestalotia*. (E. F. Guba, Waltham). This interesting but taxonomically difficult group of fungi has been the subject of critical study for several years. Part I, published in 1929, embraced a study of 46 species of which 30 were found to be distinct. Part II, of which manuscript for publication is now complete, embraces a study of 52 described species of which 38 are distinct. A key to 68 species is appended.

In general the species are saprophytes or very weak parasites, capable of infecting their susceptibles only through injuries. In the absence of biologic studies, no importance can be attached to published reports crediting species of *Pestalotia* as being true parasites.

Forcing *Gladiolus* with the Aid of Artificial Light. (L. H. Jones). Four greenhouse plots were planted with Crimson Glow gladiolus on September 6, 1930. The corms had been in cold storage since the previous March and germinated perfectly. They were planted 6 inches apart each way with a total of 70 corms in each plot. Two alternating plots were illuminated from twilight to dawn with 500-watt lights and were cuttined off from the non-illuminated check plots. One check plot produced 3 spikes of blooms; the other check plot produced none. In the illuminated plots, 81 per cent and 69 per cent of the plants produced flowering spikes. The blooms in the check plot appeared three weeks before blooms in the lighted areas. The best spikes in any plot were the first to bloom. These occurred in the illuminated plots during the first 10 days of January.

Eradication of Nematodes in Greenhouse Soils by the Use of Chemicals. (L. H. Jones). Progress has been made in substituting the liquid orthodichlorobenzene for the dry paradichlorobenzene. By adsorbing the orthodichlorobenzene with diatomaceous earth, this chemical may be mixed with cyanogas and this mixture applied to the soil in a dry state. In preliminary tests, this mixture eradicated nematodes from a soil inoculated with large nematode galls. It appears that orthodichlorobenzene has the property of aiding the soil in the retention of hydrocyanic acid gas.

Plant Containers. (L. H. Jones). Non-porous containers made of paper, glass, rubber, or metal will grow plants equal to those grown in standard clay flower pots. Paper pots should have the fibers thoroughly impregnated and bound together with some waterproofing material to prevent decomposition of the container and consequent nitrogen deficiency in the soil. Non-porous containers lose soil moisture about half as fast as do clay pots. If a clay pot is kept on a dry surface, it develops an uneven distribution of soil moisture, the lower portion of the soil gradually becoming too dry for root action even though the upper layer is moist. This condition is caused by the excessive evaporation of soil moisture through the wall of the pot, for this loss of moisture is seldom made up by the daily watering of the plants. However, if the clay pot is kept on a moist surface, the evaporated water is replaced from without the pot and not from the soil moisture. The practice of employing a moist bench for clay flower pots, therefore, assures an even distribution of soil moisture. A non-porous container cannot evaporate moisture through the wall of the container, and, therefore, the moisture is conserved uniformly throughout the soil mass. A full report of this work is given in Bulletin 277.

The common belief that aeration of the soil takes place through the wall of the clay pot may possibly be true when the pot itself is dry; but if the pore spaces are filled with moisture, which is the usual condition in greenhouse prac-

tice, it is probable that the necessary aeration of the soil can occur only through the surface of the soil. It has been found in preliminary experiments that air under slight pressure passes through the wall of a dry flower pot very slowly, and yet this rate is thirty times as fast as the rate through a moist wall.

The reaction of the soil in regard to hydrogen ion concentration is not altered by conditions in non-porous containers any more than it is in clay flower pots. The soils in paper, glass and porous clay containers in which tomato plants had been growing for 40 days all reacted the same to tests for acidity. The reaction of soils in which geranium and petunia plants were grown for nearly four months in glass and metal containers without drainage holes, was no different from that of soil in the regulation clay flower pots. The reaction of the soil in paper pots was not affected by keeping the pots on moist beds of cinders, soil, or sand or on dry benches of wood and cement.

Influence of Light Quality on Plant Growth. (A. V. Osmun). In the experiment to test the effect of Vita glass on plant growth and development, the results were comparable with those of last year. Under Vita glass, radishes seeded January 14 and harvested March 17 averaged 11.3 per cent heavier than those grown under ordinary glass. Lettuce transplanted March 16 and harvested May 21, averaged 14.2 per cent lighter in weight under Vita glass than under ordinary glass. There was no appreciable difference in compactness of heads between the two lots of plants. At no time since the experiment was started in 1928, have differences been so marked as in the first tests, when the results were strikingly in favor of Vita glass. In every test but one with radish, Vita glass has given an increase in average weight of plants, while in only one test has lettuce averaged heavier when grown under Vita glass.

Plant Diseases Observed in 1931, Not Heretofore Reported in Massachusetts. (O. C. Boyd).

Wilt and black-rot of the following cucurbits caused by *Mycosphaerella citrullina* (C. O. Smith) Gross.; vine infection only of summer squash and muskmelon; fruit infection only of cucumber; both wilt and black-rot of winter squash, pumpkin, cushaw, and vegetable marrow.

Leaf-spot of winter squash, pumpkin, cushaw, vegetable marrow, and cucumber, caused by *Bacterium cucurbitae* Bryan (determination of organism by Mary K. Bryan, U. S. D. A.).

Leaf-spot of cucumber and muskmelon caused by *Septoria cucurbitacearum* Sacc.

Bacterial seedling blight of cucumber and summer squash (organism undetermined).

Wilt of okra caused by *Verticillium albo-atrum* Reinke & Berth.

Leaf-spot of turnip caused by *Bacterium maculicolum* McC.

Leaf and pod-spot of pea (bacterial, undetermined).

Dwarf or crimps of strawberry caused by the nematode, *Aphelenchus fragariae* Ritzema-Bos. (determined by G. Steiner, U. S. D. A.).

"Stunt" or "die-out" of strawberry, suspected of being due to the virus of the true Yellows disease; observed only in Marshall berries.

Leaf-blight and rhizome-rot of iris caused by an unidentified bacterium.

Unusual Outbreaks of Previously Reported Diseases. (O. C. Boyd). Fusicladium scab of willows, rust and Gloeosporium leaf-blight of American ash, leaf-blotch of horse-chestnut, apple scab, peach bacterial-spot, brown-rot of

stone fruits, *Macrosporium* leaf-blight of carrots, black-rot of cauliflower, bacterial-wilt of cucurbits, onion "blast," *Cytospora* canker of blue spruce, hollyhock rust, bacterial-spot of delphinium, angular leaf-spot of cucumbers.

THE CRANBERRY STATION (East Wareham, Massachusetts)

H. J. Franklin in Charge

The arrangement of 1930, whereby the extension services of Plymouth and Barnstable Counties maintained a service for the cranberry growers of the two counties, was continued during the most active part of the summer season of 1931 with very satisfactory results.

Injurious and Beneficial Insects Affecting the Cranberry. (H. J. Franklin). Numerous special comparative spraying tests with the black-headed fireworm (*Rhopobota vacciniana*), in which nicotine sulfate and potash fish-oil soap, nicotine sulfate and potassium oleate soap, nicotine sulfate and penetrol, nicotine sulfate and lignin pitch-tannin mixture, pyrethrum extract, and pyrethrum soap were used, showed very clearly the marked superiority of a pyrethrum soap spray over all the other materials tried. Moreover, these tests brought out the fact that it pays to use 6 pounds of the commercial pyrethrum soap to 100 gallons of water instead of the 5 heretofore advocated. This amount of the soap was also found advisable in tests with the false blossom leafhopper (*Ophiola striatula*). The results obtained by many experienced growers in commercial practice during the season fully justified the results of these spraying experiments.

Tests with pyrethrum extract, pyrethrum soap, and nicotine sulfate and potash fish-oil soap against the red-striped fireworm (*Gelechia trialbamaculella*) confirmed previous results in showing that the nicotine sulfate spray is much the most efficient against this pest.

Tests showed that a pyrethrum soap spray (6 pounds in 100 gallons of water) is about as effective in killing moths of the cranberry girdler (*Crambus hortuellus*) as is the nicotine sulfate and soap spray (nicotine sulfate 1 qt., soap 4 lbs., water 100 gals.) commonly used to treat the black-headed fireworm.

In all the many tests made with it, pyrethrum extract was found so much inferior to pyrethrum soap in its toxic properties that its use seems seldom advisable for any cranberry pest.

Extensive dusting tests with various cranberry insects were carried out, the dust used being pyrethrum and a gypsum carrier of 300-mesh fineness. While these tests should probably be continued, the results obtained seemed to show plainly that such a dust is a satisfactory control for the false blossom leafhopper. It also killed the moths of the black-headed fireworm and so possibly may help as a control for that pest.

The general results of spraying with nicotine sulfate and soap to control the cranberry fruit worm (*Mineola vaccinii*) on various bogs were observed carefully and found to be not only encouraging but in some cases striking.

It is worth noting that the opinion is becoming pronounced among cranberry growers that the spread of the false blossom disease has been notably checked since treatments have been applied to control the leafhopper vector.

The life history of a species of *Tiphia* which is the main parasite of the cranberry root grub (*Amphicoma vulpina*) was largely worked out.

Cranberry Photosynthesis Studies. (H. J. Franklin in cooperation with the Bureau of Plant Industry, U. S. D. A.). This line of study was pursued very intensively during the summer seasons of 1930 and 1931 by Dr. William H. Sawyer of Bates College, given summer employment especially on this work, and Dr. H. F. Bergman of the Bureau. The results of their work are now being prepared for publication. A summary of their findings for 1930 and 1931 follows:

1. The climax of photosynthetic activity is reached by the middle of the forenoon (on a clear day), and the sugar content of leaves falls off after midday. This cycle of activity seems to be somewhat correlated with stomatal behavior, for in general there is a tendency for the stomata to close by noon, particularly if the temperature is high. It should be noted, however, that behavior of the stomata is exceedingly erratic, and the stomata do not all open or close at the same time, even in the same leaf.

2. The curve of sugar production in both the Early Black and the Howes varieties is subject to wide fluctuations on different days, even under apparently similar conditions of light and temperature. These fluctuations are in part correlated with the amount of sugar already present in the leaves; i.e., the gain in sugar is more rapid after a cloudy day when the sugar content is low than when the leaves start their photosynthetic activity with a sugar content already high.

3. Increase or decrease of reducing and total sugars usually, but not always, corresponds on a given day.

4. The percentage of reducing and total sugars in proportion to the weight of the leaves is consistently higher throughout the season in both young and old leaves in the Early Black than in the Howes variety.

5. An average of sugar production over several consecutive days indicates that, while the amount of sugar relative to the weight of the leaves is higher in the Early Black than in the Howes variety, the net amount produced over a given period does not differ appreciably in the two varieties.

6. Beginning with the middle of August there is a marked reduction in the amount of sugar present in both young and old leaves of both varieties. Moreover, it would appear that the withdrawal of sugar from the leaves, in comparison with its formation, is greater than earlier in the summer; and except under the most favorable conditions the withdrawal of sugar exceeds its formation.

7. The proportion of reducing sugars to total sugars in the leaves is less in the latter half of August than earlier in the season.

8. In mid-season starch is present in cranberry leaves in an amount roughly proportional to the maturity of the leaf. Little or no starch occurs in the rosette of young leaves at the top of the upright, but the amount increases progressively downward, including the old leaves. By the first of August, however, the starch stored in the old leaves begins to be withdrawn, leaving the upper layer of palisade cells first. Old leaves, by the time they turn yellow and fall, are devoid of starch.

9. During cloudy weather, or when the plants are kept in the dark, starch is removed first from young leaves near the top of the upright. A week in total darkness does not appreciably lower the starch content in the old leaves (leaves of the previous year's growth) in mid-June, but all starch is removed from leaves of the current season by such treatment.

10. In leaves of corresponding maturity there is usually more starch in those of the Early Black than in those of the Howes variety.

11. In stems, the starch in uprights is restricted to the pith; the starch in runners appears in the pith, wood rays, wood parenchyma, and outer cortex. The older portions of the stem contain most starch.

12. In the roots, starch occurs in the rays and the pericycle.

13. Oils begin to appear by the first of July in the most mature leaves of the current season as intracellular globules in the chlorenchyma, most abundant on the uppermost layer of palisade cells. These oil globules are also present in old leaves, even after they fall from the uprights. Oils in general are highly concentrated reserve foods, and in this case may help to promote new growth early in the season.

Weather Observations. (H. J. Franklin). Daily local weather observations were made and reported to the office of the Weather Bureau at Boston. Further records bearing on frost forecasting were made for the station by observers at North Harwich, East Gloucester, Carlisle, Fitchburg, Worcester, and Holliston, Massachusetts, and Storrs, Connecticut.

Pump Tests. (In cooperation with the Department of Agricultural Engineering). Several years ago Prof. C. I. Guinness tested the capacities and efficiencies of all the important bog pumps at that time in general use and published a paper on the work. This paper was well received by cranberry growers and by pump manufacturers. Since that time several new types of low-lift pumps have come into the field. As the demand was becoming urgent that these new pumps be tested, Prof. Guinness most generously undertook the work again, building a special testing plant at the Cranberry Station in 1930. He tested one pump in 1930 and completed the work during the summer of 1931, four pumps in all being tested, as follows: Fuller, Everson, Worthington, and Dayton and Dowd.

Cranberry Varieties. (H. J. Franklin). The study of varieties was pursued intensely during the early months of 1931. It was found that the species *Vaccinium macrocarpon* Ait., to which all the cultivated varieties of cranberries belong, comprises two important subspecies, and that wild hybrids between the two are very common. The Howes and McFarlin varieties were found to be such hybrids.

It was discovered that the ripe berries of most early and mid-season varieties do not have a noticeable bloom, while the fruit of most late varieties does. It has been supposed that the development of the wax of which this bloom is composed was useful to the plant as an adjustment to drouth, but the discovery mentioned suggests that with the cranberry it should rather be regarded as an adjustment to frost conditions.

Cultivated Blueberries. (H. J. Franklin). The first planting at the Cranberry Station blueberry patch was done in the fall of 1917 with about 300 untested seedlings furnished by the Bureau of Plant Industry. One of these seedlings has given an excellent account of itself and seems to be distinctly superior for commercial purposes in New England, all things considered, to any other variety so far produced. It should perhaps be patented. It has not yet been given a name but bears the culture number 1239W of the Bureau of Plant Industry. The particularly desirable features of this variety are:

1. Vigorous and plentiful wood growth.
2. Great productiveness. This bush seems to be considerably more productive than any other so far commonly grown.
3. Size of berries. The berries maintain a good size up to the very last picking in a way that those of no other variety do. While none of the berries

reach the size attained by the largest ones produced by some other varieties, the average size of all the berries is probably greater than that of any other variety.

4. Flavor of the berries. This is very good, though perhaps a bit too tart to satisfy some.

5. Keeping quality of the berries. The keeping and shipping qualities of the fruit appear to be as good as those of the berries of any variety, except possibly Pioneer and Rubel.

6. Picking quality. The berries pick easily and do not tear in picking. They cling to the bushes well and maintain a satisfactory condition while doing so, thus making frequent pickings unnecessary.

7. Cost of pruning. This is decidedly less than it is with some of the more important varieties under cultivation, especially Cabot and Pioneer.

DEPARTMENT OF DAIRY INDUSTRY

J. H. Frandsen in Charge

Factors Affecting the Aging Time of Ice Cream Mixes. (K. E. Wright). One phase of the work—the adsorption of lecithin on the fat globule in ice cream—has been completed during the year and is about ready for publication. The following conclusions have been drawn:

1. It has been definitely shown that lecithin aids emulsification of an ice cream mix when incorporated under favorable conditions.

2. The high concentration of lecithin in buttermilk appears to be associated with the low surface tension of the latter. Therefore, lecithin would tend to concentrate at the interface of a fat-serum dispersion to act as an emulsifying agent.

3. Proof has been presented that lecithin functions better as an emulsifying agent when it is allowed to be directly adsorbed to the fat surface.

4. Cataphoretic measurements have failed to reflect any influence exerted by varying amounts of lecithin and so tend to indicate a fat-lecithin-protein system because protein influenced the behavior of the globules.

5. The reason for the failure of past attempts to improve whipping property of an ice cream mix has been attributed to a disturbance of the hydrophilic colloidal nature of lecithin.

6. The aging of an ice cream mix has been considered to be a process of adsorption of lecithin by the fat surface in which the amount of aging will tend to be in inverse relation to the amount of hydrophilic lecithin present.

The Utilization of Frozen Fruits in Ice Cream and Ices. (M. J. Mack in cooperation with the Department of Horticultural Manufactures). This project, which has included four different fruit crops, is nearing completion.

During the past year fruits, principally strawberries, have been frozen in syrups varying from 30 to 60 per cent sucrose, 80 per cent invert syrup, and in partial vacuum with either sugar or sugar syrups. These have been compared with the standard pack containing 2 to 3 pounds of fruit to 1 of cane sugar. These packs have been examined and then used in ice cream.

Fruit packed in 40 per cent syrup has been found to be the equivalent of, if not superior to, the standard sugar pack. Fruit frozen under partial vacuum has the advantage of no discoloration at the surface.

Fruit ice creams made from the above packs were found to be excellent. The ice cream maker should feel free to buy frozen fruits packed in either sugar

or sugar syrup (a 40 per cent syrup being most satisfactory), either plain or vacuum packed. Any of these methods are satisfactory for storing fruits for fruit ice cream. The condition of fruit when packed, and the variety, seem to be as important as the method of packing if the fruit is to be utilized in ice cream.

About 15 per cent of frozen fruit has been found to be desirable for flavoring strawberry, cherry, pineapple, banana, and other fruit ice creams. About 20 per cent is necessary for peach, and from 10 to 12 per cent for raspberry. The fruit should be added to the freezer immediately after the freezing process is started if a short freezing time is to be realized and the maximum of flavor is to be secured. No previous preparation of the fruit, as grinding or slicing, is necessary for the smaller fruits as the dasher of the freezer will break up the fruit. Fruit ice creams should be drawn from the freezer at about 23°F.

Frozen strawberries, raspberries, peaches, nectarines, plums, cranberries, and pineapples have been found to be as satisfactory as the fresh fruit for making ices or sherbets. From 15 to 20 per cent of fruit has been found to be necessary. However, the acidity of the finished product must be increased by adding either citric or tartaric acid. The acidity content should be 0.6 to 0.8 of 1 per cent.

Titration with 0.1N sodium hydroxide solution, with phenolphthalein as indicator, has been found to be a satisfactory commercial test for acidity in ices and sherbets. Since many ices are colored pink, it would seem that the end point could not be secured with phenolphthalein as the indicator. However, the solution becomes almost colorless before the end point is reached, so that the color change at the end point is easily observed.

A Study of Ice Creams High in Fat Content. (M. J. Mack). In New England during the past 5 years, many small ice cream concerns have organized for a specialized type of business. They sell only ice creams of high fat content and do only a retail business, usually through attractive road-side stores.

The majority of these dealers buy a prepared basic mix through one of a small number of concerns specializing in this type of product. Obviously, it would be more economical if the dealer were to prepare his own mix as well as freeze it. However, difficulties arise in the preparation of a basic mix of this composition. Therefore, this project has been started with the objective of securing information concerning ice creams of this composition. No published work on this subject is available.

From the data now available, it is apparent that ice creams of a higher fat content than 18 per cent should contain no more serum solids than are furnished by the milk and cream used in their manufacture. As the fat content increases, the homogenization pressure must be decreased. A pressure of 800 to 1000 pounds is sufficient for an ice cream containing 20 per cent fat. Sufficient stability is secured from the fat and gelatin. Aging for 24 hours seems more beneficial than with ice creams of lower fat content. A high drawing temperature of about 25.5° F. must be maintained if the freezing time and yield are to be satisfactory.

To date it has been very difficult to introduce frozen cream or butter as the source of fat, for an extremely viscous product results. As the study progresses it is hoped that this and other problems pertaining to the manufacture of high fat ice creams can be successfully met.

A Study of the Effect of Various Initial Aging Temperatures on the Behavior of Gelatin in Ice Cream. (W. S. Mueller). The continuation of this study during the past year has definitely shown that aging an ice cream mix containing gelatin for 4 hours at 68° F. results in an increased efficiency of the gelatin. Of the various initial aging temperatures tried, which ranged from

50° F. to 149° F., 68° F. gave the maximum increase in gelatin efficiency. The following results were obtained when mixes aged at 68° F. for 4 hours were compared with mixes aged at the customary temperature (40° F.).

1. Improvement in texture.
2. Firmer body.
3. Increased melting resistance.
4. Slight reduction in overrun.
5. Increase in basic viscosity and gel strength when followed by a low aging temperature period.

Increasing the gelatin concentration and also the strength of gelatin (Bloom test) increased the magnitude of the high aging temperature effects. As would be expected, the mixes with low total solids were found to be benefited more by the use of a high aging temperature than were the mixes with high total solids.

The use of a 68° F. initial aging period was found to be equivalent to approximately 0.1 per cent gelatin.

A check on the possibility of any increase in bacterial growth, titratable acidity, or pH when the mix is aged at 68° F. for 4 hours showed no increase which would be of any consequence in commercial ice cream manufacture.

In an effort to ascertain the reasons for this behavior of gelatin, a thorough study of the physical properties of gelatin is being made. A study of the optical rotation of gelatin is now well under way.

DEPARTMENT OF ENTOMOLOGY

A. I. Bourne in Charge

Investigation of Materials Which Promise Value in Insect Control. (A. I. Bourne). A recent development in the field of oil sprays is the appearance on American markets of tar distillate oil emulsions which have been in general use in Europe for several years. In Europe, these oils are products of the distillation of coal, lignite and, to some extent, wood; in America, much of the material is obtained from coke ovens. Samples of both the English and the American oils were used in the tests. These oils did not prove to be as satisfactory indicators on trees in the orchard as are most of the common oil sprays; consequently a tendency to overspray the trees was unavoidable. In dormant application the English samples showed a slight tendency to retard the growth of leaf and blossom buds; the American samples did not. When applied at late dormant or delayed dormant stages of bud development, all of the oils caused severe burning and, in many cases, outright killing of the buds. In these tests the oils were not particularly effective in killing the overwintering eggs of the European red mite, being considerably inferior to most of the common oil sprays.

Tests with the typical American oil sprays included several new products which have recently appeared on Massachusetts markets. Of these, Free Mulsion (Sherwin-Williams Co.) and Oil-tone (Lucas Kil-Tone Co.) gave very satisfactory results, particularly when used at a dilution of 5 gallons to 100. Kleenup again gave a high degree of control. The red mite infestation was much heavier in the college orchards than in 1930. This emphasized the necessity for a high degree of control of the overwintering eggs, and strengthened the belief that in combating a heavy infestation the stronger dilutions of oil emulsions are advisable.

Of the miscible oils, Sunoco maintained its usual high degree of effectiveness. Scalecide was somewhat less effective than in earlier tests.

Weather conditions during early spring were very favorable. Most of the delayed dormant applications were made at temperatures of 55° to 65° F. No injury was noted following any of the oils tested. Tests of comparative coverage of two standard brands of miscible oil, an oil emulsion, and commercial lime-sulfur applied under similar weather conditions and to trees of uniform size and spread, again showed a marked advantage of the oils over lime-sulfur both in time necessary for application and in amount of material used, the oils requiring noticeably less material and approximately two-thirds of the time necessary for equivalent coverage by lime-sulfur. The tests failed to show any significant advantage of one type of oil over another, in these respects.

Further studies of various spray materials and combinations were made, in cooperation with the Department of Pomology. Especial attention was directed upon their compatibility, effectiveness as insecticides and fungicides, and relative toxicity to fruit and foliage as compared with the standard combination of lead arsenate and lime-sulfur. All the materials were applied in combination with lead arsenate, since up to the present this has proved superior to any other arsenical for general orchard use.

Combinations of lead arsenate with Sulfocide, with dry lime-sulfur, and with dry mix sulfur lime were compared with the usual combined spray of lead arsenate and liquid lime-sulfur with and without the addition of hydrated lime. These tests were made in a block containing five standard varieties of apples, namely, Baldwin, Northern Spy, R. I. Greening, McIntosh and King. The spray schedule consisted of a pre-pink, a pink and a calyx spray and two cover and two July sprays for apple maggot.

The addition of hydrated lime to the lead arsenate-lime-sulfur combination checked somewhat but did not entirely prevent spray injury to foliage. Considerable burn was noted on all varieties sprayed with the Sulfocide combination. Burn was particularly noticeable on Baldwin and King, and was accompanied by considerable yellowing of foliage and some premature drop of leaves. Dry lime-sulfur caused very little burn even on susceptible varieties. No burn was noted following the application of dry mix sulfur lime. Both Kolofog and flotation sulfur combined with lead arsenate and applied in a similar schedule to a block of McIntosh and Baldwin showed excellent persistence and gave very uniform coverage. No foliage injury was noted following the use of flotation sulfur, and but a very slight amount of burn on trees sprayed with Kolofog. The lead arsenate-lime-sulfur spray in this orchard caused extensive burn on Baldwin and considerable foliage injury on McIntosh.

The relative effectiveness of these materials is shown in the following record of McIntosh at harvest.

The addition of hydrated lime to the lead arsenate-lime-sulfur combination apparently did not impair the insecticidal value of the spray but did not give as successful control of scab as did the standard combination without lime. The Sulfocide combination failed to control scab satisfactorily and was not conspicuously successful as an insecticide. Dry lime-sulfur and lead arsenate gave good control against insects and held scab as successfully as did liquid lime-sulfur. The dry mix combination gave practically the same results as did dry lime-sulfur. Flotation sulfur and lead arsenate held scab very successfully and showed good control of insects. Kolofog did not control scab quite as well but did not impair the insecticidal action of lead arsenate.

McIntosh Apples, Block A

Treatment	PERCENTAGE OF FRUIT SHOWING	
	Insect Injury	Scab
Lime-sulfur.....	27	16
Lead arsenate.....		
Lime-sulfur.....	16	24
Lead arsenate.....		
Lime.....		
Sulfocide.....	23	39
Lead arsenate.....		
Lime.....		
Dry lime-sulfur.....	9	17
Lead arsenate.....		
Dry mix sulfur lime.....	9	16
Lead arsenate.....		
*Check		

McIntosh Apples, Block E

Flotation sulfur.....	15	0.5
Lead arsenate.....		
Kolofog.....	13	5.0
Lead arsenate.....		
Lime-sulfur.....	18	0.5
Lead arsenate.....		
**Check.....	110	35.0

*All fruit dropped; practically 100 per cent of it scabby.

**55 per cent had more than one blemish.

Similar results were secured on Baldwin. Scab was, however, less conspicuous on that variety and some differences in insect injury were noted, principally due to the longer growing season of Baldwin.

Control of Onion Thrips. (A. I. Bourne). The early season, marked by relatively high temperatures and abundant rainfall, was favorable for the growth of both seed and set onions, while the frequent and heavy rains offered less favorable conditions for the rapid development of thrips. The infestation throughout the Connecticut Valley was comparatively light and somewhat lower than in 1930. No fields were observed where thrips caused serious damage. In most of the fields of seed onions adjoining sets, the infestation was only moderately heavy, while those isolated from sets were comparatively free from thrips.

The seasonal development of thrips closely followed the normal except for a rather heavy migration of winged adults from sets late in June which took place during a period of unusually high temperature.

The great migration of thrips from sets occurred somewhat earlier than the date of the pulling of the set onions and coincided very closely with the date when those plants had matured and before they had broken over and fallen.

Studies of the effects of environment on thrips abundance in a field of seed onions exposed on the north to sets and on the south to grassland indicated the relative danger of early and heavy infestation from both sources, because of the opportunity for rapid increase offered by the sets and the excellent hibernation quarters furnished by grassland. Examination of this field, at the time when the

sets were maturing and shortly after the field to the south was mowed and hay removed, showed the following infestation.

Section of plot	Thrips per 100 plants
North side, adjoining sets	1900
South side, adjoining grassland	1760
Center	600

As the season advanced the gradual spread of the insects from each border had resulted in a heavy and more nearly uniform infestation throughout the entire field, as shown by the following.

Section of plot	Thrips per 100 plants
North side	4230
South side	3120
Center	2175

Applications of the nicotine-soap combination were sufficient to check thrips on seed onions exposed to infestation from sets. This was due in large part to the early maturity of the sets and the fact that the principal migration of thrips took place somewhat earlier than normal. Infestation was reduced from an average of 1200 thrips per 100 plants to 125 thrips per 100 plants in one field following an application of the above spray. A similar application in a second field reduced the numbers of thrips from an average of 3250 per 100 plants to 190 per 100 plants.

Predacious insects were present in such insignificant numbers that they played little or no part in checking thrips infestation.

The study of the effect of sprays and dusts on onion blast was continued in cooperation with the Department of Botany, and the work has been reported in Bulletin 279.

The Spray Residue Problem. (A. I. Bourne). Abundant rainfall throughout the summer and early fall for the most part automatically disposed of the problem of spray residue this past season. Most of the excess precipitation occurred in late August between the last applications of spray or dust and harvest. McIntosh and later varieties were practically free from residue, even in those orchards where late July sprays were applied for the control of apple maggot.

Further studies of the value of dusts for the control of late season pests such as apple maggot, late codling moth, etc., again emphasized the advantage of dusts over sprays for late summer use. Timeliness is a factor of major importance at that season. Dusts allowed a much more flexible schedule than did sprays. This advantage, coupled with the fact that dusts may be safely used during August within two to three weeks of harvest, rather more than offsets the undeniably superior persistence of sprays.

Systematic Study of Oil Sprays. (A. I. Bourne in cooperation with the Department of Chemistry). Nine samples of oil sprays prepared by the Chemistry Department were tested in the orchard to check their effectiveness against European red mite and toxicity to plant growth. The samples consisted of three different types of light lubricating oils, each combined with three different emulsifying agents. All of the samples went into solution readily, and once diluted formed a stable solution with no tendency for separation of oil, even upon

long standing. In application all the oils proved to be good indicators on the trees. There was no evidence of any retarding of development, tip burning or killing of fruit or leaf buds following any of the oils.

All the samples gave a very satisfactory kill of the overwintering eggs of the European red mite (97 per cent or better).

Apple Maggot Control. (A. I. Bourne). Control demonstrations were continued in the ten orchards in which the growers carried out the recommended program in 1930. Two additional orchards, in both of which apple maggot had been a serious pest the previous year, were included in the 1931 tests.

The same program was outlined for the growers as was followed in 1930. Particular stress was laid upon the value of close observation of the trees to detect the first appearance of the flies and their relative abundance throughout the season and thus allow better timing of the sprays or dusts. Examination of the McIntosh crop at harvest showed an average of 0.9 per cent maggot injury. In the ten orchards included in the demonstration for the second successive year, eight of the growers carried out the program in full. Maggot injury in these orchards averaged 0.5 per cent. Two of the growers carried out the program only in part. Samples checked in these orchards showed 3 to 4 per cent infestation. In the two new orchards included this season, maggot injury was held to a low figure. Their fruit showed infestation of 0.2 and of 2 per cent.

In no case was excessive spray residue found on the fruit. Growers who dusted for late applications secured fully as good results as did those who depended entirely on sprays.

A very encouraging feature of the season's results was that, without exception, growers in these tests secured better control of apple maggot than of any other major disease or insect pest.

Control of the Plum Curculio in Apples. (W. D. Whitcomb, Waltham). The activity of the plum curculio in 1931 was concentrated in the period of hot weather from May 27 to June 1, inclusive, when much damage was done to apples. However, the activity and development throughout the season appeared to be less than usual for only 1618 mature larvae emerged from a bushel of unsprayed dropped apples, compared to an average of 2854 for the three previous seasons.

In a study of hibernating environment, no beetles survived when buried in wire cages from 3 to 12 inches beneath the surface of the soil. A small number of beetles survived in cages having a protection of leaves and the survival was greater among beetles which were placed in hibernation October 1 than on September 5 or 15.

When confined in constant-temperature cabinets, eggs, larvae, and pupae died at 55° F., and development was greatly retarded at 65° F. The most favorable temperature appeared to be 75° F. where the development was slightly faster than at 85° F. The period of growth of larvae in the apples was not greatly changed at any of the effective temperatures.

The greatest number of feeding and egg punctures by adults occurred at 75° F.

AVERAGE NUMBER OF PUNCTURES PER BEETLE PER DAY

Temperature °F.	Egg Punctures	Feeding Punctures	Total
55	0.130	0.895	1.025
65	0.445	1.960	2.405
75	1.015	5.660	6.675
85	1.035	5.020	6.055

When the beetles were confined with poisoned fruit at the same constant temperatures, the number of days they lived decreased at each succeeding higher temperature, with the greatest decrease occurring between 55° and 65° F. With few exceptions, the average number of punctures per beetle increased at each successive higher temperature, but the rate of increase was small and somewhat inconsistent. At all temperatures the average length of life decreased with the increased concentration of lead arsenate until 6 pounds per 100 gallons of water was used when there was a slight increase in length of life, indicating a repellant action. These records indicate that 5 pounds of lead arsenate in 100 gallons of water was the most effective concentration to use, but the difference between that and 4 pounds per 100 gallons was slight. The addition of fish oil showed little effect in these experiments, but its use is advisable in field applications to increase adherence and spreading. A complete orchard formula containing lime-sulfur and hydrated lime was slightly less effective at the two lower temperatures but one of the best at the two higher temperatures.

The relative effectiveness of a dust and spray program for the control of the plum curculio where the fruit grower made the applications was studied under orchard conditions. The sprayed block contained Gravenstein and Astrachan, and the dusted block was made up of Gravenstein and Wealthy. Standard treatments were applied to all trees on the same day, as nearly as possible. Both blocks received liquid sprays through the calyx application. Including the "drops," 42,440 apples were examined with the following result:

PERCENTAGE OF APPLES STUNG

Variety.	Sprayed	Dusted
Gravenstein	8.54	9.43
Astrachan	4.28	
Wealthy		2.90
Total	5.74	6.12

Biology and Control of the Carrot Rust Fly. (W. D. Whitcomb, Waltham). As in 1930, the carrot rust fly was not present in sufficient numbers in eastern Massachusetts to be considered an important pest, although reports from Maine and other northern localities indicated greater numbers there.

When confined at constant temperatures, 68 per cent of the flies emerged at both 55° and 65°F.; 42 per cent at 75°; and none at 85° F. In soil with a moisture content of 25, 50, 75 and 100 per cent of its capacity at saturation, the emergence decreased from 70 per cent at 25 per cent saturation to 2.5 per cent at 100 per cent saturation. The average date of emergence decreased consistently from May 19 with 25 per cent saturation to May 25 with 100 per cent saturation, with only one individual surviving in the extremely wet soil. The flies lived longest at 55° F. but laid the greatest number of eggs at 65° F., these lower temperatures being much more favorable than the higher (75° and 85° F.). Undoubtedly temperature and moisture during the oviposition period of the first generation determine the abundance of the insect in each season. The use of an

irrigation system to maintain plenty of moisture during oviposition resulted in only a 2 per cent greater injury to carrots by the first generation but caused 13 per cent greater injury by the second generation.

The field infestation at Waltham was again so light that date of planting and variety susceptibility records were of little value, although a 38 per cent infestation in White Belgian by the first generation indicated that this variety is susceptible.

Studies of control by insecticides were greatly handicapped by the light infestation. Under the existing conditions Scotch Soot and tobacco dust were the most satisfactory, both giving nearly perfect control with a slight stimulation to the plants. These materials were applied to the crown of the plant and adjacent soil by hand at the rate of about 5 pounds to 180 feet of row.

Napthalene and Similar Materials as Fumigants for the Control of Greenhouse Insect Pests. (W. D. Whitcomb, Waltham). Fumigation with vaporized naphthalene is an effective treatment for the control of most injurious insects and mites on greenhouse plants, and with a few exceptions can be used safely when the proper conditions are maintained. In a tight chamber, the fumes from $1\frac{1}{2}$ ounces of melted naphthalene per 1000 cubic feet of air killed 93 per cent of the red spiders in one fumigation of 6 hours; but 2 or 3 ounces per 1000 cubic feet have been found necessary to counteract the leakage and adsorption in commercial greenhouses. An exposure of 4 hours is necessary to cause any appreciable kill of red spiders. Under ideal conditions, two or more fumigations using 3 ounces per 1000 cubic feet killed all red spider eggs; 12.5 per cent hatched after one fumigation, and 89 per cent of the unfumigated eggs hatched. Eggs which were 4 or 5 days old were killed more easily than newly laid eggs. The protonymphal stage of the red spider was most easily killed and the deutonymphs and adult males appeared the most resistant. Three or four fumigations are often necessary to obtain a satisfactory kill of red spider, and it was found that an interval of 1 day between treatments was more effective than an interval of 2 or 3 days, and that an interval of 3 days was 5 per cent more effective than an interval of 2 days.

Fumigation under controlled atmospheric conditions, ranging from 60 per cent to 90 per cent relative humidity and including 75° and 80° F., showed a slight but regular decline in effectiveness from the higher to the lower humidity, and a slightly increased kill at 80° F. over 75° F. However, there was a tendency toward plant injury at 90 per cent relative humidity, and the most favorable condition appeared to be a relative humidity of 80 per cent and a temperature of 80° F.

The addition of 15 per cent paradichlorobenzene to the naphthalene tended to increase the effectiveness of the fumigation with one treatment, but this formula and naphthalene alone were equally effective in two or three fumigations.

Thrips are more easily killed by this treatment than other insects although aphids and white flies are easily controlled by two or more good fumigations. Mealy bugs are very resistant, and the fumes will not penetrate the soil sufficiently to kill bulb mites. Exposed cyclamen mites are killed by 3 or more fumigations, and treatments at regular intervals keep this pest in check satisfactorily.

Carnation, begonia and cyclamen tolerate naphthalene at strong concentrations and can be fumigated safely in any greenhouse in which the necessary temperature can be maintained. Freesia, oxalis, violet and fuchsia are very susceptible to injury and should not be fumigated unless the temperature, humidity and concentration can be controlled absolutely. Chrysanthemums appear to

have a varietal tolerance which has not yet been determined. The majority of other common greenhouse flowering plants have been fumigated safely but have a small margin of safety. Tomato and cucumber plants tolerate naphthalene but the fruits absorb the odor and taste of the fumes, making the treatment undesirable.

DEPARTMENT OF FARM MANAGEMENT

J. A. Foord in Charge

Enterprise Relationships and Farm Organization on Selected Dairy Farms in Western Massachusetts. (R. L. Mighell). Bulletin 275, published during the year, explains the re-planning of three dairy-fruit farms, and the probable results. Some further work has been accomplished on time studies of farm operations, especially of chores on dairy farms.

Types of Farming in Vegetable Garden Areas. (F. H. Branch, R. L. Mighell, J. E. Thigpen). This is a cooperative project with the Extension Service, as previously noted. From the records obtained in 1930 the amount and distribution of labor expended on the different operations incident to the production of the important vegetable crops in eastern Massachusetts was determined and mimeographed for use in Extension work and at Farm and Home week. This caused a demand for the material in the Agricultural Schools and High School Departments of Agriculture, and several hundred copies were prepared for this use. Other studies are in progress.

A Study of Labor Saving Methods and Technique on Vegetable Farms. (R. L. Mighell, R. H. Barrett, J. E. Thigpen). This is a new project, intended first to develop principles and procedure for the study, and then to determine actual labor saving methods and technique. A good many studies have been made of different operations on vegetable farms, aided by the stop-watch, and both the moving picture and still camera. The crops so far considered are asparagus, carrots, beets, celery and tomatoes. A demonstration was given on the Field Day at the Waltham Field Station and some moving picture films have been prepared for use at growers' meetings.

Live Stock Management, Methods and Costs. (J. A. Foord). Those animals in the college herd showing a positive reaction to the blood test for Bangs disease have been segregated for two years ending November 1, and the labor and material costs are being assembled for use and possible publication.

The Cost of Silage Production in Massachusetts with Special Reference to the Use of Machinery. (C. I. Gunness, J. A. Foord, J. E. Thigpen). This is a cooperative project between the Bureau of Agricultural Engineering, U. S. D. A., and the Departments of Agricultural Engineering and Farm Management of the Experiment Station. Enterprise records have been obtained from more than sixty farmers in the four western counties, and for areas of from seven acres to sixty acres on individual farms. The material will be tabulated and prepared for publication during the winter.

FEED CONTROL SERVICE

Philip H. Smith in Charge

The Feed Control Service comprises not only feed inspection, but several other activities, as listed below:

- Feed Control (General Laws, 1920, Chapter 94)
- Seed Control (General Laws, 1927, Chapter 94)
- Dairy Law (General Laws, 1920, Chapter 94)
- Advanced Registry Testing
- Miscellaneous Work

Feed Control. (P. H. Smith, A. F. Spelman, G. J. Larsinos, F. A. McLaughlin, J. T. Howard). During the fiscal year, 1,591 samples of feeding stuffs were officially collected and examined in the control laboratories. The results show that at least 96 per cent of the samples collected varied less than one per cent from stated guarantees in protein, fat and fiber content. The gross receipts from the registration of feeding stuffs in 1931 (calendar year) were \$21,320, derived from 1,066 brands at \$20 each.

Seed Control. (P. H. Smith, F. A. McLaughlin, Margaret E. Nagle). From October 1, 1930, to October 1, 1931, the seed laboratory analyzed 1,135 samples of seed, of which 469 were collected by the State Commissioner of Agriculture, 216 sent in by dealers and farmers, 212 received from the Rhode Island Commission of Agriculture, and 238 purchased from wholesalers for special tests. Classification of these analyses is shown by the following summary.

Summary of Samples Analyzed

	Massachusetts Official	Massachusetts Non-Official	Rhode Island	Totals
Purity analysis only.....	34	23	25	82
Blotter germination tests....	306	368	2	676
Soil germination tests*.....		125		
Field germination tests*.....		238		
Purity and germination.	129	63	185	377
				1,135
Field crops.....	21	79	29	129
Forage crops.....	142	102	181	425
Vegetable seeds.	306	266	2	574
Tree seeds.....		7		7
				1,135

* Samples germinated in soil and field are duplications of 238 samples of vegetable seeds germinated in blotters.

Field tests to determine trueness to type were again conducted in cooperation with the Department of Agronomy which tested 9 samples of alfalfa, 12 samples of red clover, and 2 samples of sweet clover, and the Department of Vegetable Gardening which tested 125 varieties and strains of varieties of onions, and 113 samples of peas.

Dairy Law. (P. H. Smith, J. T. Howard, H. L. Allen). During the year ending December 1, 1931, 7798 pieces of Babcock glassware were tested. Condemned glassware consisted of one cream test bottle. Eighty-one certificates of proficiency were awarded.

One hundred and sixty-six creameries, milk depots and milk inspectors' laboratories were visited in order to check methods and pass upon equipment in use. As a result of this inspection, two machines were condemned outright, major repairs were ordered on six, and minor repairs on twenty. Where it is thought necessary, re-inspections will be made. Special investigations were made at ten plants.

Advanced Registry Testing. (P. H. Smith). Advanced registry testing has been supervised by this department since its beginning in 1902. There are now on yearly test 528 cows located on 67 different farms. This does not include the herd tests where all animals in each herd are placed on test. Of these there are fourteen, two of which are supervised by men sent out from this office and twelve by cow-test association supervisors.

Miscellaneous Work. (P. H. Smith, A. F. Spelman, G. J. Larsinos). Numerous analyses have been made for residents of the State and other departments of the College. Especial attention is called to the increasing number of dry matter determinations in connection with forage crop experiments. This work has become a real burden upon other work of the department and should it increase materially, the employment of an additional assistant during the summer months will be necessary.

Summary of Miscellaneous Work, 1931

Materials sent in:

Milk and cream, butterfat only.....	461
Milk, solids and fat.....	4
Feeds.....	104

For other departments of Experiment Station and College:

Milk, for butterfat.....	138
Milk, for solids.....	10
Dry matter, forage crops.....	2,255
Complete fodder analyses.....	167
Dry matter and nitrogen.....	49

FERTILIZER CONTROL SERVICE

H. D. Haskins in Charge

Fertilizer Inspection. (H. D. Haskins, H. R. DeRose, A. F. Spelman, G. J. Larsinos, and J. B. Zielinski, Jr.). During the season, 125 firms or individuals have registered for sale in Massachusetts 589 brands of mixed fertilizers and fertilizing materials and 26 brands of agricultural lime and gypsum. Statistics with reference to the inspection of these products are given in the following summary.

The four agents who secured samples of fertilizer and lime for the year's inspection sampled 24,925 sacks or containers, representing 10,753 tons of material; 873 agents were visited.

Products	Brands Regis- tered	Brands Col- lected	Samples Col- lected	Number of Analyses	Number of Determin- tions
Mixed fertilizers.....	357	344	1207	467	6071*
Ground bone, tankage and fish.....	56	50	165	65	301
Nitrogen products, organic and mineral.....	71	64	270	177	531
Phosphoric acid products.....	31	27	117	32	128
Potash products.....	21	21	72	32	116
Cotton hull ashes and wood ashes.....	9	8	12	11	46
Ammoniated superphosphates.....	4	4	5	4	40
Nitrate of potash.....	7	6	12	9	36
Dried, pulverized natural manures.....	23	23	94	22	110
Peat products.....	7	7	10	6	30
Miscellaneous.....	3	3	9	4	23
Lime products.....	26	26	68	27	190
Totals.....	615	583	2041	856	7622

* Not counting check tests or repeats, which would amount to at least one-third more in number.

From July 1, 1930, to July 1, 1931, the tonnage of fertilizer and plant food sold in Massachusetts was as follows:

	Fertilizer (Tons)	Plant Food Elements (Tons)		
		Nitrogen	Available Phosphoric Acid	Potash
Mixed fertilizers.....	43,463	1,916	3,473	2,827
Unmixed fertilizer chemicals and materials.....	19,174	1,084	1,630	561
Pulverized natural manures.....	2,426	42	30	87
Totals.....	65,063	3,042	5,133	3,475

Full details of the fertilizer and lime inspection will be found in Bulletins 60 and 61, Control Series.

Miscellaneous Analytical Work. (H. D. Haskins, H. R. DeRose, A. F. Spelman, and G. J. Larsinos). The cooperative chemical work which was carried on with other departments of the Experiment Station covered the usual range of projects and comprised the following analyses:

Cured hay, partial ash analysis.....	53
Pasture grass, partial ash analysis.....	22
Peat, fertilizer analysis.....	2
Farm manures.....	4
Complete fertilizers.....	6
Unmixed fertilizer materials.....	23
Ashes of peat.....	1
Charcoal.....	2
Iron sulfate.....	2
Soils, special study tobacco root-rot.....	12
Soils, mechanical analysis.....	12
Soils, partial analysis.....	4

Requests for analyses from farmers and farm organizations have received the usual attention. A nominal charge has been made for such work when of interest only to the individual. Results of analysis are always interpreted and suggestions are made as to the practical application of the work. The following materials have been examined under this heading:

Unmixed fertilizer materials	10
Complete fertilizers	3
Lime products	3
Manufacturing by-products	6
Farm manures	2
Peat products	12
Miscellaneous	7
Soils, partial analysis	28

The usual interest has been taken during the year in the work of the Association of Official Agricultural Chemists, Mr. Haskins having served as President of the Association and as Chairman of the Committee on Definition of Terms and Interpretation of Results on Fertilizers and Lime Products.

DEPARTMENT OF FLORICULTURE

Clark L. Thayer in Charge

Study of the Effect of Plant Nutrients on Carnations and Roses Under Glass. (H. E. White, Waltham). Experimental work has been carried on with different fertilizer materials to determine what effect the sources of nitrogen and phosphorus may have upon the growth of carnations and roses.

There have not been any outstanding differences in the number or quality of carnation flowers produced by the plants in the different fertilizer plots. Applications of nitrogen in the short, dark days of December did not noticeably increase splitting of calyces. Plants receiving calurea, urea, and blood produced a few more split calyces than plants in some of the other treatments, with the exception of the manure plots. Splitting of calyces appears to be a genetical tendency or varietal peculiarity. Spectrum has a greater tendency to split than either Ivory or Woburn. Nitrogen starvation symptoms appeared by midwinter on the manure and peat plots; light applications of sodium nitrate restored the plants to their normal condition.

A peculiar physiological disturbance was observed in the sodium nitrate plots. The petals of the affected flowers grew out beyond the calyces but they appeared to be glued together. When such flowers were soaked in alcohol, the bases of the petals were found to have adhered. However, the upper portions were easily freed from one another by the alcohol. This condition has been encountered in local greenhouses but so far the causes have not been satisfactorily explained. The manure plots which showed nitrogen deficiency and received sodium nitrate produced flowers showing this adhesion. Further investigational work is being carried on to determine the cause of this trouble.

There were no outstanding differences in the fertilizer trials with roses. The plots are being carried on for another season since the present plants have been in the plots for one year only. If the results warrant it, the work will be continued.

Breeding Snapdragons for Varietal Improvement and Disease Resistance. (H. E. White, Waltham). In the summer of 1930 rust resistant plants of the Mains' strains from Purdue were selected in the field and planted in the greenhouse for breeding. Some 50 different crosses were made between these strains and greenhouse varieties. The progeny of these crosses, consisting

of approximately 8000 plants, were planted in the field and inoculated with rust during the summer of 1931. The different crosses showed varying degrees of susceptibility to rust. A number of very resistant white and yellow flowered individuals were selected from the F₁ generation for further breeding work. Further selections and breeding are being carried on to obtain resistance combined with qualities desired in commercial varieties.

DEPARTMENT OF HOME ECONOMICS

Bernice Wait in Charge

The Comparative Value of Milk and Tomato for Supplementary Feeding in Elementary Schools. (E. Davies, B. Wait, and M. V. E. Voorneveld). This study of experimental supplementary feeding of children in a small consolidated rural school is being continued for a third year. Observation of the children indicates that there was some improvement in their general well-being as a result of the feeding either of milk or of tomatoes. Whether the data obtained will confirm this observation, or whether the improvement in the condition of the children was sufficient to be measured by the tests applied, cannot be ascertained until the tabulation of the data has been completed.

The Value of Evaporated Milk for School Food Service. (E. Davies, B. Wait, and O. A. Merriam). In this project, which is similar in method and purpose to the above, evaporated milk is being given to the children of the first four grades in the schools of a small mill village. The children of the same grades in the schools of a neighboring village are being used as a control group. While the tabulation of the data obtained from the first year of the study has not progressed to the point where definite conclusions are warranted, general observation of these children, as of those receiving fresh milk and tomatoes, suggests that there is an improvement in the general well-being of the children as a result of the school feeding.

DEPARTMENT OF HORTICULTURAL MANUFACTURES

W. W. Chenoweth in Charge

Fruit Juices and Jelly Making. (C. R. Fellers). Three summers' work on methods of extracting juices from small fruits for jelly manufacture has now been completed and the results tabulated.

The examination of sodium benzoate samples for suitability as cider preservatives has been continued. Marked differences exist among these preparations as to ability to impart flavor. Several new German preservatives, derivatives of benzoic acid, show very promising results in cider preservation.

A new type of jelly tester was designed with J. A. Clague and thoroughly tested with the cooperation of Chatillion Bros., instrument makers, of New York. A description of the instrument appears in *Industrial and Engineering Chemistry, Analytical Edition*, 4:106-7, 1932. This new instrument combines low cost, adaptability, ease and speed of operation, mobility, and simplicity. Its use will enable manufacturers of fruit or pectin jellies to control consistency in their product. The tester works equally well with canned cranberry sauce.

Work was completed and a paper presented before the American Chemical

Society in September, 1931, on "A rapid centrifugal method for pectic acid determination." This paper has been accepted for publication by *Industrial and Engineering Chemistry*. The method greatly shortens the usual analytical procedure for pectin determinations in fruit products.

Effect of Microorganisms on the Jellying Power of Fruit Juices. (C. R. Fellers, J. A. Clague, and R. L. France). Data obtained in this cooperative project with the Bacteriology Department show that yeasts do not affect the jellying power of pectinous solutions. Several molds, however, are very active in the decomposition of pectin and render fruit juices containing them incapable of being used for jelly. Bacteria will be next studied in this connection.

Preservation and Nutrition Studies with Cranberry Products. (C. R. Fellers and J. A. Clague). Further laboratory and commercial experience has proved that canned cranberry sauce should have a soluble solids content of approximately 42-43 per cent. At our suggestion commercial canners are now using Abbe refractometers to control the finishing point on canned cranberry sauce. By this means uniform consistency and maximum yields are obtained.

Dr. H. J. Franklin of the Cranberry Station furnished us with 39 varieties of Massachusetts-grown cranberries last year and 25 varieties of New Jersey and Wisconsin cranberries this year. These varieties are being tested for suitability for manufacture of strained and whole-fruit cranberry sauce. Results to date indicate that only a few varieties are suitable for sauce; the only way some of the poorer varieties can be used at all is by blending. Each variety is also tested for pectin and benzoic acid. Preliminary analyses indicate a great variation among varieties in benzoic acid content; for example, the Early Black has 0.04-0.05 per cent as against 0.09-0.10 per cent in Howes variety. We plan to see if there is any relation between keeping qualities of varieties and benzoic acid content.

Vitamin studies (C. R. Fellers and P. D. Isham) on cranberries and cranberry products have been continued with the aid of funds made available by the American Cranberry Exchange. Cranberries and wild blueberries are moderately rich sources of vitamin C, from 3 to 4 grams daily sufficing to protect 300-gram guinea pigs. Unstrained cranberry sauce retained about 80 per cent of the vitamin C; but the strained sauce, pasteurized juice, and dried cranberries contained scarcely any of this vitamin. Studies are now under way to determine the vitamin A, B, and D potencies of cranberries. The work on blueberries will also be continued.

Physiological studies on human subjects showed that large doses of cranberries (100 grams or more) greatly increased urinary acidity and markedly lowered the blood alkali reserve. Small daily feedings of 22 grams produced no acidosis but did increase the acidity of the urine. Indirect calculations from the hippuric acid content of the urine following cranberry ingestion lead to the conclusion that from 0.6-0.85 per cent of quinic acid or a related substance is present in cranberries. This substance acts similarly to benzoic acid in the body and like the latter is eliminated as hippuric acid.

Methods of extraction of cranberry juice are being studied with the cooperation of C. C. Rice. Cranberry juice makes a popular beverage and is especially suitable for blending purposes because of its high flavor, acidity, and color.

Utilization of Onions by Canning and Drying. (C. R. Fellers). The continued examination of experimental packs of canned onions has further

proved that, with careful attention to details, onions may be successfully canned. Cooperative work on discoloration in canned onions has been conducted with C. P. Jones of the Department of Plant and Animal Chemistry.

Cull onions were again dehydrated and manufactured into onion powder. This powder retains all the natural flavoring principles of the onion, even after two years' storage in sealed containers. Samples have been distributed to various persons and agencies with a view to popularizing this new product.

Utilization of New England Fruits in Ice Cream. (C. R. Fellers and M. J. Mack). This cooperative project with the Department of Dairy Industry is now in its third year. The data are being assembled for a bulletin.

Effect of Freezing and Thawing on Microorganisms in Foods. (C. R. Fellers). The bacterial content of vegetables, fruits, meats, and fish which had been frozen for a year was determined. A similar determination was made after the frozen products had been defrosted for 24 hours. In general, the solidly frozen foods contained few bacteria (0-270,000); while, after defrosting at room temperature for 24 hours, the numbers were excessive in the case of vegetables, eggs, and oysters, and actual decomposition was evident. Manifestly, frozen vegetables and marine products should be promptly consumed after defrosting. Frozen fruits were still relatively free from spoilage and edible 48 hours after defrosting. A paper on "Public health aspects of frozen foods" was read before the American Public Health Association in September, 1931, and has been accepted for publication in the journal of the association.

Research on Dates. (C. R. Fellers and M. M. Cleveland). This investigation is financed by The Hills Brothers Company of New York. The study of the mineral composition of dates over a three-year period has been completed. The ash of dates is high and contains over 40 per cent K_2O , thus making the date an excellent acidity corrective.

A new product, known as date butter, was developed. This product will help utilize that part of the date crop which, though perfectly edible, cannot be sold as whole dates.

Dried date pulp is being tested for suitability for poultry food, in cooperation with the Poultry Department.

Vitamin Content of Baldwin Apples and Other Fruits. (C. R. Fellers and M. M. Cleveland). The native Baldwin apple has a relatively high vitamin C content. Feeding tests with guinea pigs showed no differences in the vitamin C content of sprayed and unsprayed Baldwins. Samples of fresh cider, pasteurized cider, lumpy (unstrained) apple sauce, and smooth, screened apple sauce made from Baldwin apples of known vitamin C content, are being tested for vitamin C.

Canned citrus fruits, oranges and grapefruit, contained fully as much vitamin C as the fresh fruits purchased in Amherst during July and August.

Canned Rat Baits. (C. R. Fellers in cooperation with E. M. Mills, Bureau of Biological Survey, U. S. D. A.). The canning of cereals, fish, and meat mixed with red squill has been perfected. In this way the baits will keep indefinitely, are convenient to use, and can be packed at a central factory and shipped to demonstration centers as desired.

DEPARTMENT OF PLANT AND ANIMAL CHEMISTRY

J. B. Lindsey in Charge

The Effect of Fertilizer and Cultural Treatment on the Nitrogenous Compounds of Havana Seed Tobacco. (E. B. Holland and E. Bennett). The analytical work on tobacco has been continued along similar lines as in previous years with the exception that many duplicate samples have been sweat to determine the effect of the additional treatment on the nitrogenous compounds of the leaf. In view of the fact that recent investigators have stressed the carbohydrates as a criterion of quality, it would seem advisable to broaden the inquiry and attempt to correlate the carbohydrates and nitrogenous compounds with burn and character of ash. Substantially all the chemical work planned for the season has been completed and the results await examination.

Tobacco Field Experiments. (Compiled by E. B. Holland and E. Bennett). Experiments in raising Havana Seed tobacco have been conducted on the station plots since 1924 to determine the effect of various cultural and fertilizer treatments on the total yield, grades, and market value of the crop. The data for the 1924-1930 crops inclusive have been recalculated and compiled for publication and present many interesting facts concerning the size and weight of leaf of the several grades under the various treatments.

Oil Sprays. (E. B. Holland). Work has been continued with a light paraffin base oil, a medium paraffin oil, and a naphthene base oil. Miscibles were prepared from all three lubricating oils by three methods and applied in field tests under the supervision of the Entomology Department, with satisfactory results.

Spontaneous methods of preparation again proved preferable to the old process requiring heat, and an organic base more efficient than alkali. The oils themselves have been submitted to various physical tests to determine their position in the field of lubricants.

Nitrogen Fixation in the Presence of or as a Result of the Growth of Legumes versus Non-Legumes under Certain Defined Agronomic Conditions. (F. W. Morse). This year (1931) oats were grown on the non-legume areas and field peas together with oats on the legume areas. Nitrogen was omitted from all plots this year as has been the procedure in alternate years. Eight annual crops have been removed from the plots since the beginning of the experiment, and a summary of the results is given in addition to those of the current year.

Results from Plots 7 and 9 which have not received any nitrogen in fertilizers since 1882 are compared with those from Plots 8 and 10 which have received nitrogen regularly, the former in sulfate of ammonia and the latter in organic animal matter. The comparison for this year, however, is between no nitrogen and residual nitrogen from previous applications. The figures are averaged from each pair of plots.

The crops this year (1931) were harvested for fodder just as the seed began to fill out. It made little difference in the yields whether nitrogen had been omitted for fifty years or only one year. Combining peas with the oats increased the dry matter about 25 per cent and the nitrogen over 70 per cent.

Crops on the non-legume areas during the eight years were hay, corn fodder, Japanese millet, corn fodder, hay, hay, Japanese millet, oat hay. On the legume

*Dry Matter and Nitrogen Removed from Non-Legume and Legume Areas
in 1931 and in 8 years
(Pounds per Acre)*

	WITHOUT NITROGEN		WITH NITROGEN	
	Dry Matter	Nitrogen	Dry Matter	Nitrogen
Non-Legume, 1931.....	2,105	26.9	2,194	28.0
Legume, 1931.....	2,600	45.8	2,659	49.5
Non-Legume, 8 years.....	23,886	254.9	33,395	354.5
Legume, 8 years.....	28,058	534.4	29,867	563.3

areas they were clover hay, corn fodder, soy bean fodder, corn fodder, clover hay, clover hay, Japanese millet, pea and oat hay. On the non-legume areas the plots which had received 180 pounds nitrogen in 8 years produced 9500 pounds more dry matter per acre which contained 100 pounds more nitrogen than was obtained from the plots that had been without nitrogenous fertilizer for 50 years. The use of leguminous crops made the nitrogenous fertilizers comparatively ineffective. The gain of 1800 pounds of dry matter and 29 pounds of nitrogen was due mainly to the non-leguminous crops used in the rotation.

The soil from each individual section of the plots was sampled and analyzed in 1924, 1927, and 1931. To check results, a few samples of 1924 and 1927 were again analyzed simultaneously with the samples of 1931. The repetitions varied only a trifle from the originals, proving that reagents had been carefully prepared in each season. The individual analyses are averaged and summarized in the table.

*Percentages of Nitrogen in Surface Soil
(Depth 8 inches)*

Year	WITHOUT NITROGEN		WITH NITROGEN	
	Non-Legume	Legume	Non-Legume	Legume
1924.....	.130	.135	.158	.133
1927.....	.190	.160	.195	.180
1931.....	.165	.170	.170	.168

The figures clearly show no deterioration in soil nitrogen in the absence of nitrogenous fertilizers, and no accumulation of nitrogen in the soil where they were used. Since 254 pounds of nitrogen were removed from the soil where no legumes had been grown for 8 years, it appears that this nitrogen was supplied by soil organisms which took it from the air. Growing leguminous crops in rotation doubled the amount of air nitrogen thus secured.

Chemical Study of Cranberries. (F. W. Morse). At the request of Dr. H. J. Franklin of the Cranberry Station, analyses were made of Early Black and Howes cranberries which had been produced in a comparison of dry bogs versus watered bogs during the season of 1930. Dry matter, total acids calculated as citric acid, and total sugar were determined, with the results shown in the following table.

Composition of Cranberries from Dry and Watered Bogs

	EARLY BLACK		HOWES	
	Dry Bog	Watered Bog	Dry Bog	Watered Bog
Dry matter, per cent.....	12.43	11.77	14.21	13.48
Total acid, per cent.....	2.29	2.28	2.06	2.08
Total sugar, per cent.....	3.60	3.31	4.34	3.81

Cranberries from the dry bog contained more dry matter and sugar. Acid was unaffected. The berries from the dry bog appeared slightly wilted in comparison with those from the watered bog and averaged smaller in size. Several varieties of cranberries were analyzed and were all within the range of composition reported in Bulletin 265.

Astringent matter, wax, and quinic acid have been determined in some of the most common varieties of cranberries.

Determinations of wax were made by extracting the dried and pulverized cranberries with carbon tetrachloride. This solvent was used instead of ether because ether will dissolve malic acid which occurs in cranberries. Besides the wax which exists in the skin, the extract includes oil from the seeds; but seeds form only a small part of the fruit. The percentages of wax extract in 14 varieties ranged from 0.34 to 0.63. The wax was subsequently separated into two substances, one soluble and the other insoluble in petroleic ether. The insoluble material is a dry, resinous substance, while the soluble is soft and greasy in appearance. The wax is similar to the wax in apple skins and further study of it is intended.

Astringent matter was determined by the usual method of titration with potassium permanganate, and fresh fruit was used. The range of percentages in 12 varieties was from 0.25 to 0.46. Variations between varieties were too narrow to explain differences in quality.

The presence of quinic acid in cranberries was first announced this year by Kohman and Sanborn (E. H. Kohman and N. H. Sanborn, *Indus. and Engin. Chem.* 23:126, 1931). It does not lend itself to a sharp quantitative separation from the citric and malic acids which occur with it in the fruit. A tentative method was devised based on the different solubilities of lead and calcium salts of citric, malic, and quinic acids. The range of approximate percentages in numerous determinations in 12 varieties was from 0.45 to 1.1 per cent.

Milk Substitutes in the Growing of Young Calves. (J. B. Lindsey and J. G. Archibald). The problem is worthy of continued study because of the demand for fluid milk and the lack of skim milk for feeding. During 1930 studies were made of the so-called dry feeding method which consisted of feeding milk for the first four weeks of the calf's life and then substituting a dry grain mixture and alfalfa or rowen. While it is possible to grow Holstein or other rugged calves by this method, they appeared thin and not in as satisfactory condition as those receiving skim milk or diluted skim milk powder for a longer period of time. Therefore we do not feel like commending it.

At present the following method is being used with a group of calves: Whole milk is fed for one week, skim milk powder in the proportion of 3½ ounces to each quart of warm water gradually substituted and fed until the calves are six to eight weeks old, then replaced by a dry ration using an animal meal instead of the more expensive skim milk powder. It is hoped that for conditions prevailing in Massachusetts some such method will prove satisfactory and economical. Thus fed, an average rugged calf would receive, up to four months of age, about 50 quarts of whole milk and 60 pounds of skim milk powder in addition to rowen or alfalfa and a grain mixture.

Two Systems of Dairy Cattle Feeding—High Roughage and Low Grain versus Low Roughage and High Grain. (J. B. Lindsey and J. G. Archibald). This project was organized and started in the autumn of 1928 and was intended to continue for several years. The object has been to determine the effect of

maximum roughage and low grain (1 pound of grain to 4½ pounds milk) fed to one group of cows, and minimum roughage and high grain (1 pound of grain to 2½ pounds milk) fed to another group, upon the economy of milk production and the condition of the cows as regards appearance, live weight, and breeding. The roughage has consisted of first-cut hay, rowen, silage and green forage fed in different amounts; and the grain, of a mixture of wheat bran, ground oats, corn meal, gluten feed, and cottonseed meal, mixed in different proportions for the two groups. A statement of the results from October, 1928, through February 1, 1931, follows:

	High Roughage	Low Roughage
Proportion grain to total feed, dry matter (per cent):		
October, 1928 to October, 1929.....	21.5	36.5
October, 1929 to February, 1931.....	19.1	35.3
Dry matter required to produce 100 pounds milk (pounds):		
October, 1928 to October, 1929.....	107	97
October, 1929 to February, 1931.....	118	107
Net energy required to produce 100 pounds milk (therms):		
October, 1928 to October, 1929.....	610	600
October, 1929 to February, 1931.....	639	636
Feed cost of 100 pounds milk:		
October, 1928 to October, 1929.....	\$1.74	\$1.75
October, 1929 to February, 1931.....	1.70	1.67

It is clear that the high-roughage cows required more dry matter to produce a definite amount of milk than the low-roughage cows. The calculated therms of net energy, however, did not vary much for either group. When it came to a matter of feed cost, the results were about the same in each case on the basis of market price for all feeds. While for a definite amount of feed the low-roughage ration produced more milk than the high-roughage ration, the feed cost per unit of milk was about the same.

It might be added that the cows in both herds kept in good condition and did not show breeding troubles, although it must be admitted that the low-roughage cows presented the better appearance.

Mineral Requirements for the Growth of Dairy Heifers. (J. B. Lindsey and J. G. Archibald). Results of one phase of this project have been published in the *Journal of Agricultural Research* 42:883-896, June 15, 1931, in an article entitled, "The calcium requirements of dairy heifers."

Work on the phosphorus requirements is being actively pursued, although it has been seriously interfered with by the loss of two heifers which reacted to the tuberculin test in February. Forty metabolism balance trials with eight heifers have been completed. Four of these heifers have received a basal ration low in phosphorus, while for the other four the basal ration has been supplemented with sufficient organic phosphorus to double the amount of that element fed. The work has not reached a stage which warrants reporting any results. During the year the capacity of the equipment for conducting balance experiments has been doubled by the addition of two more metabolism stalls.

Studies in the Chemistry of Pasture Grasses. (J. G. Archibald and E. Bennett). A final report summarizing three years' work on the original project reported on in 1929 and 1930 (of which the present project is an outgrowth) has recently been prepared for publication.

Other phases of the more comprehensive project have progressed to the following extent:

1. In a study on nitrogen partition to determine what portion of the nitrogen in grasses is combined in true protein and what portion may be combined in the amino form or in the even simpler forms of ammonia and nitrates, 26 samples of grass have been analyzed. Half of these came from quite heavily fertilized pastures and the other half from unfertilized pastures. Some of them were from the college and experiment station farms, others came from Middlesex and Worcester Counties. Two samples of a pure stand of white clover, one fertilized and the other unfertilized, were also included in the study. The analyses showed:

In fertilized grass, the amino nitrogen constituted approximately 11.3 per cent of the total nitrogen; in unfertilized grass, it amounted to about 8.5 per cent of the total nitrogen.

In fertilized white clover, the amino nitrogen was slightly over 23 per cent of the total nitrogen; while in the unfertilized white clover, it was slightly under 21 per cent.

Ammoniacal nitrogen averaged about 1.8 per cent of the total nitrogen where fertilizer had been used and about 1.0 per cent where it had not been used.

There were only slight traces of nitrate nitrogen in any of the samples.

2. The survey of natural pastures throughout the State had to be temporarily suspended this year because the soil maps of the important pasture areas still unsurveyed were not available, being still in process of publication. It is hoped to continue and complete this phase of the work next season. Analyses have been completed of forty samples taken in Worcester and Berkshire Counties in 1930, and the following conclusions are offered:

Results indicate a natural pasturage on the predominant soil types of Berkshire County superior in both quantity and quality to that on the predominant type in Worcester County. This is attributed to heavier soils with greater moisture-holding capacity.

Judged by the standard of a recognized authority, these pastures measure up quite well. In general the only deficiency suggested is in the element phosphorus.

The ratio of calcium to phosphorus is probably too high, due partly to the low phosphorus content and (in the case of at least one soil type) partly to a rather high calcium content.

3. The study of the chemical composition of different species of grass involved the collection in 1930 of 50 samples of grass from plots growing pure stands of timothy, redtop, blue grass and white clover; and the collection in 1931 of 60 samples from plots of orchard grass, sheep fescue, Rhode Island bent, and Canada blue grass, in addition to the above-mentioned species. Analysis of the 1930 samples has been completed and studied in detail. Analysis of the 1931 samples is now in progress. Conclusions on this phase of the work are withheld until more data have been accumulated.

Utilization of Onions by Canning. (C. P. Jones). This is a continuation of the study reported in the annual report for 1929 (Bulletin 260). Work during the past year has been confined largely to a study of the Yellow Globe onion and its behavior during and subsequent to canning.

Onions put up by the Department of Horticultural Manufactures and held in tin containers for two years, adsorbed more of the corrosion products of the can than was found in the liquor. Amounts determined were influenced some-

what by differences due to individual cans, type of can, and weight of onions packed.

A commercial brand of onions packed in enameled cans was examined five to six months after canning. Only a light brown discoloration of the onions developed upon long exposure to the air. Very little, if any, corrosion of the can was noted. Onions packed in similar cans and kept in storage for a little over two years, discolored considerably upon long exposure, the discoloration developed more slowly, and the ultimate color was more of a dark brown than dark olive green. Unfolding the cans revealed no evidence of corrosion at the junction of ends and sides or along the side seam. Discoloration of bulbs in this instance could not be associated with the metal of the can, and the cause must be looked for elsewhere.

The 1931 crop of commercially canned onions, processed in plain tin containers, was examined two to three months after canning and showed only a slight discoloration of the tinned surfaces of the can. Long exposure of the onions to the air failed to produce any appreciable discoloration. Treatment of the bulbs with dilute ferric chloride solution resulted in no discoloration. Improved methods of canning are probably responsible for this better condition. The onions were whiter and smaller in size than the Yellow Globe Danvers variety.

DEPARTMENT OF POMOLOGY

F. C. Sears in Charge

The crop of peaches in the Station orchards was about as large as that of 1930, but the apple crop was about one-half that of last year. This is probably due largely to the heavy crop of 1930. Studies of the air temperatures during and immediately following bloom showed that during this period in 1930, high temperatures prevailed to an exceptional degree. This may be the chief reason for the heavy crop. Fluctuations in crops during the past ten years did not follow the lesser differences in temperature very definitely.

The Interrelation of Stock and Scion in Apples. (J. K. Shaw and J. S. Bailey). Alternate trees in the main orchard in this project were removed during the past winter. This project may be considered as finished though further observations on the remaining trees may be made. Eight rows of "permanent" trees were top grafted to new varieties in the spring of 1931.

This orchard has suffered in some years from a peculiar "tip burn" of the leaves. A trouble similar in appearance has been attributed to potash deficiency. In this orchard it is evidently correlated with water supply of the trees. The orchard has never received any potash fertilizer so it was felt that a potash deficiency might be a factor. A strip involving two rows of trees was plowed in the spring and a liberal application of muriate of potash given to one of these rows. The tip burn was not prevalent in the orchard the past summer. There was no evidence that potash had any influence in the limited amount that appeared.

Efforts to propagate Malling Stocks by mound layering were continued. These are expected to yield a considerable number of rooted stocks when dug next spring. These will be used to establish a new and larger stock bed.

The orchard of McIntosh and Wealthy on Malling Stocks made a satisfactory growth during the season and showed considerable bloom and some fruit.

The average growth of the trees during the four years they have been in the orchard is as follows:

Increase in Trunk Diameter in Four Years
(Own-rooted trees=100)

Stock	McIntosh	Wealthy	Stock	McIntosh	Wealthy
1	99.7	50.2	10	89.4	93.6
2	13.1	41.2	12	98.4	126.6
3	7.7	20.6	13	77.3	98.9
4	114.7	104.9	15	79.6	99.3
5	80.9	94.0	16	106.4	134.8
6	77.3	76.8	Own-rooted	100.0	100.0
8	23.2	44.9	Seedling roots	93.8	109.0
9	27.1	33.8			

Stocks 4, 12, and 16 seem to be standard stocks, while the others dwarf these two varieties in varying degrees. The difference between the two varieties when worked on Stock 1 is exceptional. Stocks 2 to 9, inclusive, are represented in small numbers, which may well explain the differences which appear.

Tree Character of Fruit Varieties. (J. K. Shaw and A. P. French). Further studies of nursery trees of different varieties of tree fruits have been made in connection with the certification work of the Massachusetts Fruit Growers' Association and with inspection work in other nurseries. Photographs showing the varietal characters of one and two year trees as grown in the station nursery have been made. This work will be continued next year and should furnish material for a publication setting forth variety characters better than can be done in any other way. A revision of Bulletin No. 208 was published during the year as Bulletin No. 274, "The Identification of Apple Varieties from Non-Bearing Trees."

The Genetic Composition of Peaches. (J. S. Bailey and A. P. French). In the spring of 1931 a number of seedlings were crossed and selfed to get an F₂ generation. Very few fruits were obtained because of unfavorable weather conditions following the hand pollinations.

The study of tree and fruit characters of the seedlings was continued. The results are in agreement with the statements made last year.

Several times during the winter the temperature fell below enough to kill some of the fruit buds. Part of the seedling orchard experienced a temperature of -18° F. Some of the fruit buds survived. More time, therefore, was given to determining the percentage of buds killed under outside conditions and less time to work with the freezing apparatus.

Testing Methods of Pruning. (J. K. Shaw). This project with young bearing apple trees has been continued as usual. No new developments have appeared. Under the conditions of this test no marked benefits from pruning are apparent. This should not be interpreted as meaning that bearing trees need not be pruned. Under conditions of good orchard management light pruning is probably desirable, but heavy or even moderate pruning seems to interfere with maximum production with no very distinct improvement in quality.

Effect of Pruning Bearing Apple Trees. (W. L. Cutler). The fifth year of this experiment in an orchard over forty years old was continued with no new trends appearing. This was the off-bearing year, and the crop was less than one-half of that of 1930 and somewhat scattered among the different varieties and trees.

This orchard was originally used as a test of different fertilizers and contained one plot which had received no fertilizer. In 1925 this plot was in very poor condition and since then it has received nitrate of soda at the rate of 500 or 300 pounds per acre. It is interesting to note that these trees have steadily improved in vigor, and for the past two years the crop has compared favorably with that of the fertilized plots, considering that the trees are considerably smaller.

Comparison of Cultivation and Sod in a Bearing Orchard. (J. K. Shaw). This experiment has continued as modified in 1927. The sod plot receiving potash in addition to nitrogen continues to give an apparently larger yield of McIntosh and possibly of Baldwins than the companion plot receiving only nitrogen. The sod plot receiving 500 pounds per acre of nitrate of soda continues to yield slightly better than the plot receiving only 300 pounds. The cultivated plot with 300 pounds per acre of nitrate yielded more in 1931 than the plot without nitrogen, but not such a remarkable excess as in earlier years.

It seems doubtful whether an orchard can be maintained in sod so as to give maximum yields, even with rather liberal applications of nitrogen.

The orchard formerly used in a study of head formation in apple trees is now used for a fertilizer test, and regarded as a part of this project. Three of the seven plots received no fertilizer from planting to 1931, while the other four received nitrate of soda at the rate of 200 pounds per acre beginning in 1925. Beginning in 1931 two of the unfertilized plots received nitrate at the rate of 300 pounds per acre applied in the fall, while two of the nitrate plots received muriate of potash in the spring at the rate of 200 pounds per acre. There are no indications that potash has increased yields, while the fall nitrogen applications after the harvest could not influence the crop in 1931. The nitrogen plots yielded between two and three times as much as the plots which never have received nitrogen.

Comparison of Clover Sod and Grass in a Sod Mulch Orchard. (J. K. Shaw). This orchard was limed in the spring of 1931 and the fertilizer treatments continued as before. White clover continues to prevail in the potash-phosphorus-lime plots, but the yields in 1931 were only about one-half those of the complete fertilizer plots. The percentage of fruit dropping was, as last year, larger on the complete fertilizer plots.

Tests of Different Amounts of Nitrate of Soda. (J. K. Shaw). This project has been modified by applying the fertilizer only in the non-bearing year. This calls for omitting fertilizer in the spring of 1932. Yields continue to be larger with larger amounts of nitrogen.

Comparison of Cultivation and Heavy Mulching for Apples and Pears. (J. K. Shaw). Most of the pear trees have been removed from this orchard. Since it is apparent that cultivation without nitrogenous fertilizers is not a wise orchard practice, the cultivated plots received nitrate of soda at the rate of 300 pounds per acre beginning in 1931. The McIntosh trees have apparently responded to this treatment, giving the largest yield of any year except in the heavy crop year of 1930. The Wealthy trees have given a less distinct response but the crop was very small, this being the off-bearing year.

The Effects of Fertilizer Limitation on Fruit Plants. (J. K. Shaw). The old "soil test" field was replanted in the spring of 1931 with own-rooted

McIntosh and Wealthy apple trees. Care was taken to have the trees on the several plots of the same average size, though the individual trees showed some differences owing to variation among the trees available. With one or two exceptions the trees started and made good growth. The fertilizer treatment on Plot 11 was changed to 8 pounds superphosphate, $5\frac{1}{2}$ pounds muriate of potash and 8 pounds nitrophoska and that of Plot 13 to $14\frac{1}{2}$ pounds superphosphate, 8 pounds muriate of potash and 12 pounds of tankage. The fertilizer treatment of all other plots was continued as in previous years.

Role of Potash and Lime in Fruit Tree Nutrition. (J. K. Shaw). This study by means of pot cultures was continued. The use of sulfur to acidify soil from the potash-phosphorus-lime plot proved very injurious to the trees. Lowering the pH value to 4.0 or less apparently prevented nitrification and nearly or quite prevented growth of the seedling peach trees used as indicators. Aluminum sulfate used for the same purpose had little effect. Nitrogen carriers other than nitrate of soda favored growth. These included ammonium sulfate, urea, calurea, blood, fish, and cottonseed meal. Lime favored growth as in previous years.

Effect of Potash and Lime on Apple Trees. (J. K. Shaw). This project is carried on in a sod orchard of Wealthy trees planted in 1915. It was planned to throw light on several questions that are of interest to fruit growers, the most important of which were the value of the addition of potash and phosphorus to nitrogen, and the value of lime as a supplement to the different mixtures used. As the trees tend strongly to biennial bearing, some trees bearing heavily one year and some the other, the yields must be considered in two-year periods.

It was assumed that in this orchard nitrogen was necessary. The question whether potash added to nitrogen increased the yield is not yet positively answered. Half of the plots were limed and half were unlimed. The unlimed plots averaged 8 per cent more than the limed plots in 1930-1931. The nitrogen plots yielded about one-third more than the plots without nitrogen, while with the 1928-1929 crops the increase was about one-fifth. This suggests the probability of increasing differences in later years.

The potash and phosphorus plots yielded moderately heavy crops and there is reason to believe that on this soil such a fertilizer is better than none. The average plot yield per tree varied from 382 pounds to 855 pounds. It is evident that factors other than fertilizer treatment are responsible for the larger differences in yield.

Study of Varieties of Tree Fruits. (J. K. Shaw and O. C. Roberts). This project has been broadened to include small fruits as well as tree fruits. It is impossible to say with accuracy just what varieties are "new." We have the following numbers of varieties which we consider may be called new: apples, 59; peaches and nectarines, 33; pears, 5; plums, 11; cherries, 8; grapes, 20; blackberries, 9; raspberries, 20; blueberries, 16; strawberries, 16. Most of these varieties will doubtless prove of no value, but among them are probably a very few that will rise to considerable commercial importance.

Among the new varieties of apples are about a dozen red-fruited variants from well-known varieties. Some of these promise well; others are little better than the older varieties. There are several distinct sports of Gravenstein among which the one originating in Washington and distributed by the New York Fruit Testing Association seems superior. Starking and Richard seem to be more desirable than Delicious. It is not known that Gallia Beauty is a bud

sport of Rome, but we have been unable to distinguish between trees of these two varieties. Gallia Beauty seems like Rome in fruit and superior in color to both Rome and Red Rome. We now believe that there may be two "strains" of McIntosh, one of which shows striping while the other does not. Usually one is nearly, or quite, as well colored as the other. Red Spy is more red than Northern Spy, but it is not much more attractive in appearance than well-colored specimens of Northern Spy. Red Duchess is but little better in color than Oldenburg.

Golden Delicious is too much inclined to be russeted and to wilt in storage to be desirable for planting here. It bears at an early age, produces well and is of high quality. It may be worth planting for a special market. Macoun continues to give promise and is well worth extended trial.

The New Jersey peach varieties continue to promise well and will in time replace most of our present early and mid-season varieties.

Portland is a promising early white grape. Among new raspberries, Lloyd George produces large berries of good quality, a few being produced in the fall. Thus far it has been resistant to mosaic. Newburgh continues promising; its greatest fault is that it is very thorny, making picking somewhat unpleasant.

The Howard 25 strawberry which we have tested for several years has been introduced to the trade as Howard Supreme and is now available to strawberry growers. It has been very productive, exceeding Howard 17 (Premier) during the past five years as follows: 28, 50, 15, 98, and 58 per cent. It should be remembered that these figures represent small plots in the vicinity of its place of origin. It remains to be seen whether it will maintain this high productiveness under extensive commercial tests. It is an imperfect or pistillate variety.

Fruit Bud Formation in the Strawberry. (R. A. Van Meter). This project was started in the spring of 1928 to study the effect of the supply of soil nitrates on fruit-bud formation and fruit production. Nine fertilizer treatments are involved, each replicated five times on plots of thirty plants each. Runner plants were removed.

There were applied to each plot two pounds of a mixture of 200 pounds of superphosphate and 50 pounds of muriate of potash. This was worked into the soil after the plants were set.

Differential treatments to the 1931 plots were as follows:

- 1—No nitrogen.
- 2—August 17, nitrate of soda.
- 3—August 17, sulfate of ammonia.
- 4—August 17, calurea.
- 5—September 15, nitrate of soda.
- 6—September 15, sulfate of ammonia.
- 7—September 15, calurea.
- 8—October 19, sulfate of ammonia.
- 9—To be applied in spring, sulfate of ammonia.

The treatments have made no apparent differences in plant growth during the first summer.

Bud Mutations. (W. H. Thies). The selections from bud sport limbs have made good growth, but it will be several years before they all reach fruiting age.

Light Pruning of Young Grapevines. (B. D. Drain). This project was discontinued, following the resignation of Prof. Drain. The work indicated possibilities of greater leaf area and heavier production on vines lightly pruned

with thinning of the blossom clusters, as compared with the heavy pruning usually given grapevines.

Storage of McIntosh Apples Under Various Conditions. (O. C. Roberts cooperating with C. I. Gunness and W. R. Cole). This work has been continued in much the same manner as reported one year ago, with a few changes and additions as stated in the report of the Department of Agricultural Engineering.

Study of Various Spray Materials. (O. C. Roberts cooperating with A. I. Bourne). This year certain spray materials were given further field tests, and a few materials not tested previously were included. A summary of this project is contained in the report of the Department of Entomology.

Blueberry Culture. (J. S. Bailey). Propagation work has continued with increased success. Five box frames, as described by Johnston of Michigan, were constructed and proved very satisfactory for this work. The rooting of dormant cuttings taken in the spring was more successful than the rooting of green-wood cuttings taken in the summer. Granulated imported peat was used as the propagating medium. A preliminary experiment on the application of a complete nutrient solution to the rooted cutting in the propagating beds gave promising results. About 5000 cuttings of several varieties were rooted.

Cross Pollination and Sterility Studies with Certain Apple Varieties. (F. C. Sears, O. C. Roberts and others). The work on pollination of apples was continued with the following varieties: McIntosh, Cortland, and Northern Spy.

DEPARTMENT OF POULTRY HUSBANDRY

J. C. Graham in Charge

Broodiness in Poultry. (F. A. Hays). Non-broody and intense broody lines have been continued. The plan is to develop both lines for genetic similarity, except for the genes concerned with broodiness and with the intensity of broodiness. The non-broody generation hatched in 1930 consisted of 36 birds. Of this number 29 or 80.56 per cent were non-broody during the first laying year and averaged 227 eggs. The 7 broody birds in this line averaged 192 eggs. The intense-broody line of 1930 consisted of 23 birds and was 100 per cent broody. The mean egg record of this line was 180.

Data indicate that degree of broodiness is inherited. In general, a high degree of broodiness seems to dominate a low degree of broodiness in crosses.

Breeding Poultry for Egg Production. (F. A. Hays and Ruby Sanborn). Early sexual maturity and high persistency are the most uniform inherited characteristics in the flock. Intensity is high in the flock as a whole, but the variability in families is high. Special attention is being given to matings to secure greater uniformity for high intensity. The percentage of broodiness in this flock does not exceed 10 per cent.

Special attention is being given to improving egg size without sacrificing desirable fecundity traits. There has been an increase in egg size, but the mean annual production for the last flock was only 206 eggs. Vigor, as measured by mortality rate in the laying houses, has been improved and hatchability is constantly increasing.

Statistical Study of Heredity in Rhode Island Reds. (F. A. Hays and Ruby Sanborn). Complete data on the cost of raising pedigree pullets and cockerels to 162 days of age were collected on the Station flock and reported in Poultry Science, May, 1931. All data on time required to reach standard egg weight have been tabulated for use. Data on types of intensity and on persistency have been prepared for publication.

A Genetic Study of Rhode Island Red Color. (F. A. Hays). Birds bred for standard qualifications above gave an average annual production of 130 eggs. Those selected for color from the production strain averaged 196 eggs. First-generation females produced by crossing high-fecundity females with a standard-bred male exhibited early sexual maturity, high intensity, and high persistency, further substantiating the dominance of these traits. Broodiness was increased to 55 per cent. The mean annual egg record of this first generation was about 195.

In plumage color the first generation cross is intermediate between the parent color. There is, however, a considerable range in plumage color. The effects of heterosis were shown by increased body weight.

Determination of Genetic Laws Governing Results of Inbreeding. (F. A. Hays). Mating father on daughters resulted in a marked decrease in annual production as compared with the parental stock. The mean egg record of the inbreds was 180 eggs while that of the parental stock was well above 200 eggs. The second generation produced by half brother-sister matings is not promising.

Hereditary and Environmental Characteristics Affecting Variability in Egg Production. (F. A. Hays). This experiment has been concluded with the generation hatched in 1930. Results will be published in the near future.

Factors Affecting Egg Weight and Shell Character in Domestic Fowl. (F. A. Hays). Three lines are being developed based on the ability of the females to lay 52-gram, 57-gram and 59-gram eggs, respectively, in the month of December. The fourth generation was hatched in 1931. The data so far substantiate the proposed theory that gene A for small eggs is epistatic to gene B for large eggs.

Relation of Intensity or Rate of Laying to Feather Pigmentation. (F. A. Hays). This project terminates with the generation hatched in 1930. Data are being prepared for publication.

DEPARTMENT OF VETERINARY SCIENCE

J. B. Lentz in Charge

Poultry Disease Elimination Law. (H. Van Roekel, K. L. Bullis, O. S. Flint, and Miriam K. Clarke). During the 1930-31 season, 402,983 blood samples, representing 356,810 chickens in 447 flocks, were tested for pullorum disease. Compared with the previous season, increases were observed in the number of tests and the number of tested birds. The average percentage of infection was 1.47, the lowest attained in eleven seasons. The number of birds in 100 per cent tested, non-reacting flocks increased. Infection was found in 26 flocks which were non-reacting in 1929-30. The reported possible sources of infection were failures to observe sound eradication measures. No reactors were detected among 2,099 fowl other than chickens.

A three-day conference for poultry disease laboratory workers of the Eastern States was sponsored by this laboratory. Thirteen states and two Canadian Provinces were represented. Pullorum disease, coccidiosis, and infectious laryngotracheitis were discussed. The purpose of this conference was to solve poultry disease problems and to standardize and adopt uniform, sound methods which will prove practical and effective in control or eradication.

Pullorum Disease Investigations. (H. Van Roekel, K. L. Bullis, O. S. Flint, and Miriam K. Clarke).

1. Twenty hens negative to the tube agglutination test were allowed to range on soil contaminated with droppings collected each week from reacting hens. Two yards, approximately 8 x 12 feet, were used alternately for periods of six weeks. At the end of the first six weeks, twelve birds were added to the flock. All hens continued to be negative to the agglutination test. Twelve birds died during the course of the investigation and at the end of 24 weeks, the remaining birds were necropsied. *S. pullorum* was not isolated from these 32 birds.

2. Twenty-four non-reacting pullets (eight weeks old) from a pullorum disease free flock were placed with twenty-four reacting pullets (nine to thirteen weeks of age) from an infected flock. The two groups were kept together until sexual maturity was attained. The non-reacting pullets remained negative for 111 days while in contact with the reactors, and for 70 days after the reactors had been removed.

3. Five hens and seven pullets negative to the tube agglutination test were fed fresh eggs laid by pullorum-infected hens. All birds were fed a minimum of 30 feedings and one received as many as 65. Each bird received one egg per day and was tested at frequent intervals. All birds were necropsied one month after the last feeding with the exception of one which died of a septicemic form of the disease 14 days after the last feeding. Two hens, including the fatal septicemic case, became definitely infected as indicated by agglutinins in the blood stream and the recovery of *S. pullorum* at necropsy. In two pullets, agglutinins were produced but *S. pullorum* was not isolated.

4. The testing of naturally and artificially infected chicks revealed that agglutinins were first detected between the ages of three and four weeks. Among chicks artificially infected and first tested at the age of four weeks, all infected individuals were detected as reactors before twelve weeks of age. Some reactors detected during this age interval later became negative. *S. pullorum* was isolated from chicks four to eight weeks old whose sera did not agglutinate pullorum antigen.

5. Pullorum infection was not established in pigeons when a suspension of the organism was fed to two pigeons and instilled into the eyes of two others for a period of six weeks. The birds were negative according to the tube agglutination test and on necropsy *S. pullorum* was not isolated. Three additional pigeons were inoculated intraperitoneally. Clinical manifestations of the disease and agglutinin production were observed. The disappearance of agglutinins was rapid and on necropsy *S. pullorum* was not recovered.

6. Sparrows appear to be susceptible to pullorum disease, as demonstrated by subcutaneous and intraperitoneal inoculations, by instillation into the eye, by forced feeding, and by exposure to contaminated feed and litter. Characteristic gross lesions of pullorum infection were observed and *S. pullorum* was recovered.

7. Concentrated pullorum antigen stored at 8° C. was tested at frequent intervals. The comparisons with freshly prepared antigens revealed that the antigenic properties were not affected at the age of 64 weeks.

8. Dilute pullorum antigen was divided into three equal parts. One part was titrated to pH 8.4, one part to pH 7.2, and one part to pH 7.2, but raised to Hp 8.4 at the time of each test. The antigens were stored at 8° C. and tested at frequent intervals with five positive and five negative pullorum sera. Consistent macroscopic antigenic differences were not observed among the antigens over a period of fifteen weeks.

9. Antigens were prepared monthly from three sets of cultures over a period of 45 weeks. Two sets of cultures were transferred at monthly intervals, one being retained at 8° C. and the other at room temperature (approximately 22° C.). The third set was transferred at weekly intervals and retained at room temperature. Comparative tests of these antigens during this period revealed no consistent antigenic macroscopic differences.

10. *S. pullorum* was observed to remain viable on a dry piece of cloth in a Kolle flask for 26 weeks. The viability observations are being continued.

Laboratory Service—Pathology. (G. L. Dunlap). This service was used by 311 persons, 92 of whom called either to deliver specimens or to discuss poultry diseases. A total of 1,046 specimens was received. Parasitic infestations continue to be the most frequent diseased conditions sent to the laboratory. Avian tuberculosis, fowl cholera, and fowl typhoid were not encountered this year. Carbon monoxide poisoning was diagnosed in two lots of chicks.

B. aerytrycke infection has been found in a number of pigeon lofts and an attempt is being made to eradicate the disease in one loft by means of the agglutination test.

A study was made of so-called "crazy chicks." The uric acid content of the blood of affected chicks was found to be two to six times greater than normal. Epithelial degeneration of the kidney and proventriculus was the prominent lesion. Details of this work were presented at the annual meeting of the American Veterinary Medical Association (Kansas City, August, 1931) as Massachusetts Agricultural Experiment Station Contribution 125, "An Ataxia of Chicks Associated with Nephritis."

The causes of mortality in the Station flock are being studied in an effort to minimize these losses.

Farm and Station Bang's Disease. The laboratory, in assisting this project, has recorded 966 agglutination tests.

Infectious Laryngotracheitis. (C. S. Gibbs). Studies on chronic carriers of infectious laryngotracheitis in poultry have been continued. Among 520 birds examined by direct swabbing of the trachea, 17 chronic carriers have been found. The longest time a carrier eliminated virus was 378 days and the shortest time was 14 days. Three of the chronic carriers have not yet completed the carrier stage. Thirteen may be classified as constant and four as intermittent in type. A more expedient test to detect chronic carriers is needed.

Studies indicate that the most common channel of infection is the respiratory tract.

Pullets and cockerels, as well as adult birds, may be immunized by intravenous and subcutaneous inoculations of small doses of filtered virus over a long period of time. No practical method for immunization of birds on a large scale is recommended.

Moldy Corn. (C. S. Gibbs). The feeding of moldy corn did not produce watery eyes or laryngotracheal symptoms, as has been reported. Severe intestinal reactions occurred in all of the chickens when first placed on the moldy corn ration, and one died of enteritis. After feeding on moldy corn continuously for four weeks, the chickens apparently developed a tolerance and did not show any further ill effects.

Infectious Bronchitis. (C. S. Gibbs). A streptococcus has been found in baby chicks apparently responsible for an epizootic with symptoms resembling infectious laryngotracheitis. The microorganism is a new species and attacks the bronchial tubes of baby chicks. This disease should be called infectious bronchitis, and it should not be confused pathologically with infectious laryngotracheitis, which is due to a filtrable virus.

Avian Paralysis. (C. S. Gibbs and G. L. Dunlap). A limited study of avian paralysis has been made. Nutritional, parasitic, and neoplastic types have been recognized. These three types are distinct entities. The first two forms are preventable and sometimes curable. The neoplastic form of paralysis is not so well understood and presents a real problem to poultrymen and pathologists. Our studies have been confined largely to this type and are being conducted along two lines.

1. Two groups of breeding fowls have been selected for mating to determine if the disease is transmitted through the egg. One group of these fowls has a definite history of paralysis, while the history of the other is free of the disease. One hundred and ninety-nine chickens hatched from these matings are under observation.

2. Sixty-four chicks have been inoculated by different methods, using neoplastic tissues from affected fowls to determine if this material is infectious. Some of these birds are still under observation.

THE WALTHAM FIELD STATION

(Waltham, Massachusetts)

Ray M. Koon in Charge

The research work of this Station has been conducted principally along the same lines as in 1930. As rapidly as results have been obtained they have been released to the commercial growers for application to their problems, without waiting until the completion of the entire project.

The use of the Station as a center of practice demonstrations and as a bureau of horticultural information has shown a marked increase. During the year 1400 persons visited the Station seeking individual assistance from members of the staff; Field Day attracted 860 more; the attendance at the School for Commercial Florists was 140; and 657 registered at the School for Home Gardeners. Thus the Station has served some 3000 visitors who have come for one reason or another. Telephone queries have numbered 1345, and 2450 letters (not circular) have gone out in answer to requests for information.

A strong interest has been manifested by the commercial nurserymen in having the Experiment Station institute investigations in their behalf at the Waltham Station. A bill for an appropriation to provide for this work is in the process of drafting and will be presented to the legislature during the session of 1932.

For reports on experiments conducted at this Station, in addition to those listed under this caption, see report of the Departments of Botany, Entomology and Floriculture.

The Plant House. (P. W. Dempsey). Interest on the part of growers in this superior method for growing plants continues. A new set of plans including some improvements over the original plant house has been mimeographed, for the purpose of mailing in response to definite requests. Since this project was started in 1928, some 2000 copies of plans and specifications have been distributed throughout New England, and many visitors have come to the Field Station with the sole idea of looking over the model plant house which has been erected here.

Electricity as a Source of Heat in the Hotbed and Propagating Bench. (P. W. Dempsey). Three hotbeds of four sash each were operated in the early spring to determine the comparative merits of manure, hot water and electricity as sources of heat. Considering both the cost and the results obtained, electricity at 5 cents or less per kilowatt hour is entirely practical for the grower using less than fifteen sash. The commercial production at a fair price of a practical lead-covered, almost foolproof, heating cable and a reliable thermostat makes this new method of heating hotbeds available to the grower. Work will be continued to gain more essential knowledge along this line. A mimeographed set of plans and specifications was made in the late spring and over 200 copies have been distributed in response to requests for information.

The same equipment, cable and thermostat can be used as a source of bottom heat in the propagating bench and elsewhere in the greenhouse. Last winter considerable work was done using strip heaters, coiled resistance wire, and other heating elements, but all of these became decidedly antiquated upon the introduction of the lead-covered cable in February of this year. At present, December, 1931, there are being maintained five different temperatures under carnations, four different temperatures in the propagating bench, and a heating cable under two rows of cucumbers providing a differential of 10° F.

Most of this work is done in cooperation with the Edison Electric Illuminating Company of Boston and the General Electric Company.

Vegetable Variety Trials. (P. W. Dempsey). Forty varieties and strains of lettuce were planted at various times during the season. The so-called "White Big Boston" variety continued to show outstanding qualities that make it worthy of trial by lettuce growers. For three years unsatisfactory results have been obtained from many strains of the Black Seeded Tennis Ball type. From similar reports made by growers it would seem that this variety may be going to pieces. We have been recommending it for years as the standard head lettuce variety. Next year we are planning a thorough study of the Black Seeded Tennis Ball and White Big Boston varieties.

Fifty-two strains and varieties of sweet corn were planted at two different dates. Spanish Gold, a new introduction from Dr. Jones of Connecticut, showed up exceptionally well as a high yielding early yellow corn. Golden Gem as the earliest yellow corn of fair size and good quality, and Golden Sunshine as a standard variety to replace Golden Bantam continued to show great promise for the future.

Forty strains and varieties of beets were seeded in two plantings. The variety names Crosby Egyptian and Early Wonder are practically synonymous.

The several strains of each variety tested for the past four years show decided similarity in all characteristics. Dark strains of Crosby Egyptian are being featured by seedsmen, their only difference from the old type being in the elimination of the light zones showing so plainly on a cross section of most strains of this popular variety.

Twenty-three varieties and strains of tomatoes were planted, half of the number of plants of each strain being staked and the other half grown flat. The new variety Break O' Day introduced by the U. S. D. A. did not show up well in our trials. It was not as early as described in comparison with other varieties; the plants were uneven in maturity and type of growth; and the fruit was uneven in shape, size, and color. Bison and Progress, two new varieties from North Dakota, proved unsatisfactory since most of the fruit was of exceptionally poor shape. After four years in our trials we have decided not to include the Burbank variety again. From our results it appears to be a poor strain of Earliana.

Asparagus Investigations. (Robert E. Young).

Fertilizers. Two of the three series of asparagus fertilizer plots planted in 1928 were cut for the first time this season. The growth of the asparagus on the Concord plots was so small that the cutting of any spears would have permanently injured the bed. The beds at Waltham and Eastham were cut for a period of two weeks each. Because of the short cutting period, the yield records cannot be interpreted to the extent of saying that any one fertilizer treatment was better than another. There was a wider spread in yields between duplicate plots with the same treatment than between different treatments.

The pH determinations have been made on all of the plots to determine the effect of the different fertilizer combinations on the soil reaction. In all three experiments, organic fertilizers such as fish, guano, cottonseed meal and goat manure had a marked tendency to make the soil acid. The depression of the pH was as much as two points in some instances. The application of ammonium sulfate did not have the same effect on the pH on all plots. On the sandy soil on the Cape this fertilizer did not affect the soil reaction to a very marked extent except on the acid soil. On these plots the growth was less than half as high as on the surrounding plots, and the stand had decreased 50 per cent. On the Waltham plots, sulfate of ammonia did not affect the soil reaction very significantly.

The growth of the asparagus on the plots at Eastham has varied quite widely. Before the asparagus was planted, one-half of this land had a crop of carrots that was not harvested but plowed under; a large crop of turnips was harvested from the other half. The asparagus plots located on the soil which had previously grown the carrots produced a much larger yield than did the other plots. The line of demarcation was plainly visible throughout the growing season. The yield records from these plots show that the most important factor in the growth of asparagus in the Merrimac coarse sand, which is typical of the soil on Cape Cod, is the supply of organic matter in the soil.

Depth of Planting and Height of Cutting. The cutting season for these plots was the full period of six weeks. The records for the cutting show that the more green that is allowed to develop (8 inches to 12 inches), the more pounds of asparagus may be removed per acre. There was no significant difference in yield per plant of asparagus planted at the various depths; but there was a wide variation in the mortality of plants planted at the various depths, as is shown by the following table.

Depth of planting Inches	Plants alive Per cent
2	89
4	87
6	81
8	70

This reduction in the number of plants would decrease the yield per acre to a very marked extent.

Seed Improvement. (Robert E. Young, Waltham). Selections were made from eight F₂ strains of Blue Hubbard Squash. Some of the strains show promise of being high yielders and of high quality, but these strains are not the shape that is desired by our market. Crosses have been made with other strains to obtain the desired shape. Dry matter was determined on many squashes and some variations were found. Some selections will be made on this basis to try to obtain dry type squash.

Selections were continued on twenty strains of Horticultural Beans. The beans from a few of the strains showed the color desired by our market. Studies are being continued in the greenhouse to determine the factors affecting coloration of the bean pods.

The sport of Oshkosh pepper that has been grown at the Waltham Field Station for some time has been found to set well under the adverse conditions sometimes found around Boston. This pepper produces fruits that are varied in shape and not very desirable for green peppers. Selections and crosses are being made to improve this condition.

Selections are being continued on the Bel-May Lettuce to keep up the foundation stock.

Selections on the Wyman Crosby Beet were continued for both shape and zoning, in an attempt to improve the foundation stock of this beet.

The foundation stock of the Hutchinson Carrot is being maintained. One thousand pounds of seed were produced in California for distribution in 1932.

COOPERATIVE TOBACCO INVESTIGATIONS

Conducted by the Bureau of Plant Industry, United States Department of Agriculture, in cooperation with the Massachusetts Agricultural Experiment Station. C. V. Kightlinger, U. S. D. A., in Charge

Black Root-Rot. (C. V. Kightlinger). In 1930 sixteen different strains of Havana Seed tobacco were grown in the field in an attempt to find, if possible, strains that, under Connecticut Valley conditions, are satisfactory for resistance to black root-rot, for type of plant, for type and quality of leaf, and for producing capacity. Four of these were strains of Havana Seed commonly grown in the Connecticut Valley, known to be acceptable for type of plant and type and quality of leaf, and used as standards of comparison in these respects. One strain was Havana 142A3, known to be satisfactorily resistant to black root-rot, and used as a standard of comparison in this respect. Eleven strains were new strains of Havana Seed whose properties had never been determined under Connecticut Valley conditions.

In these tests, none of the more common strains of Havana Seed showed satisfactory resistance to black root-rot as strains, nor was it possible to select

individual plants within these strains which seemed to be satisfactorily resistant. Eight of the new strains seemed to be approximately as resistant to black root-rot as Havana 142A3, as determined by comparison of producing capacities and infections of black root-rot when grown in soil which was heavily infested with *Thielavia basicola*.

The producing capacity of the four common strains, of Havana 142A3, and of these eight new strains, as indicated by the yields in 1930 on soil free or nearly free of *Thielavia basicola*, are shown in the following table:

	Yields per Acre	Grade Index
	Pounds	Values
Havana Seed—common strains	1818	.458
	1908	.436
	1769	.445
	1879	.438
Havana 142A3	2083	.491
	1984	.453
	2111	.505
	2015	.496
Havana Seed—new strains	1996	.492
	1987	.493
	2031	.528
	1897	.491
	1897	.490

Eight of the eleven new strains were satisfactory for resistance to black root-rot and for yielding capacity; but one of these eight was definitely unsatisfactory for type of plant and type and quality of leaf, and for this reason was discontinued. Thus far it appears that seven of the new strains of Havana Seed may be acceptable for resistance to black root-rot, type of plant, type and quality of leaf, and yielding capacity. These deserve further testing.

Mosaic. (C. V. Kightlinger). It has been determined experimentally that tobacco mosaic virus, contained within tobacco debris mixed with moist sandy loam soil, clay soil, or sandy soil and kept under out-of-doors conditions except for leaching, in each case retained its viability for two seasons sufficiently to produce infections of mosaic when suspensions of such mixtures of soil and debris were inoculated into healthy tobacco plants by the needle method.

In inoculation tests by the needle method, it has been found that formaldehyde, acetic acid, and several other substances, when mixed directly with the expressed juices of mosaic-diseased tobacco plants, were able to inactivate the virus sufficiently to prevent infections. Whether these chemicals, when used as seedbed disinfectants in the usual manner and in the usual amounts and concentrations, may be able to inactivate the mosaic viruses contained in seedbed soil, has not been definitely determined. Preparations have been made for final tests of this point, and the actual tests will be made next spring and summer.

PUBLICATIONS

Bulletins

- 270 Meteorological Records—A Forty-Year Summary, 1889-1928. C. I. Gunness. 20 pp. December, 1930.

This is a monthly summary of records kept at this institution since the work was started in 1889. The position of the observatory is given, with enough information about the instruments used to enable the reader to interpret the records.

- 271 Annual Report for the Fiscal Year Ending November 30, 1930. 64 pp. February, 1931.

The main purpose of this report is to provide an opportunity for presenting, in published form, recent results from experimentation in fields or on projects where progress has not been such as to justify the general and definite conclusions necessary to meet the requirements of bulletin or journal.

- 272 Experiments with Hedges. Frank A. Waugh. 24 pp. March, 1931.

Hedges are coming back into fashion. They always were both useful and beautiful when properly placed and well kept. They serve as boundaries on property lines, as enclosures to gardens, as windbreaks, and for privacy in the home grounds. Many species of trees and shrubs will make good hedges under suitable management. This fact gives range for critical choice of materials. The Department of Landscape Architecture, Massachusetts State College, has maintained a demonstration and experimental garden for testing hedges for ten years, and this bulletin is a report of that work.

- 273 Infectious Trachitis. Charles S. Gibbs. 32 pp. April, 1931.

Infectious trachitis has been the cause of heavy losses to the poultry industry in the State of Massachusetts. Evidences are apparent that these losses are increasing, and there is a pronounced interest in methods of prevention and control. This study of the disease, its symptoms, pathology and mode of transmission, was undertaken to furnish a basis for procedure in perfecting control methods. (Technical).

- 274 The Identification of Apple Varieties from Non-Bearing Trees. J. K. Shaw and A. P. French. 32 pp. April, 1931.

Much of the disappointment and financial loss caused by planting misnamed trees could be avoided if varieties were known as young trees in the nursery, or even if misnamed trees were detected soon after planting in the orchard. Varieties of apples can be recognized by tree and leaf characters as easily and surely as by the characters of the fruit. This bulletin discusses and illustrates some of these characters.

- 275 Planning the Farm Business on Three Dairy-Fruit Farms in Massachusetts. R. L. Mighell. 28 pp. June, 1931.

Farm adjustments made by individual farmers often serve as valuable guides to others in similar situations. This study presents an analysis of some common types of problems for which solutions have been found to fit in these particular cases. Exactly the same adjustments might not fit other farms. They may, however, serve as suggestions to other farmers in like situations.

- 276 Increasing Soil Acidity as a Means of Controlling Black Root-Rot of Tobacco. William L. Doran. 30 pp. June, 1931.

Soil with a pH value of about 5.9 or higher are favorable to the growth of the fungus which causes black root-rot and are therefore unsafe for tobacco. The primary object of the work here described was to study means of lowering the pH value of soil infested with *Thielavia basicola*, and thereby decreasing the loss caused by black root-rot of tobacco.

- 277 Flower Pot Composition and Its Effect on Plant Growth. Linus H. Jones. 16 pp. October, 1931.

The ordinary flower pot of fired clay has been the standard plant container for many years. In recent years, however, flower pots of other materials have come on the market; and of these, paper pots have received most consideration because of their economic advan-

tages. A result of this interest has been a pronounced demand for reliable information concerning the comparative merits of different types of containers. The investigation reported in this bulletin was begun in response to this demand, and has given results which are applicable either to the production of greenhouse plants in wholesale quantities or to the growing of a single house plant.

- 278 Infectious Laryngotracheitis Carriers. Charles S. Gibbs. 12 pp. December, 1931.

The investigations on infectious laryngotracheitis for the past year at this Station have centered largely around carrier problems and control measures. While the goal has not been reached, important advances have been made, and the disease can now be handled under laboratory conditions more effectively than it was a year ago. The results contained in this paper are in no sense complete, but are published in the hope that poultrymen and others interested in the control of infectious laryngotracheitis may find in them some practical applications under field conditions.

- 279 Onion Spraying and Dusting Experiments. W. L. Doran and A. I. Bourne. 12 pp. December, 1931.

In 1927 and 1928 seed onions died prematurely in the Connecticut Valley of a disease here designated as blast. In earlier years, downy mildew of onions has also sometimes caused a reduction in yields. The field experiments here described were undertaken with the object of learning to what extent fungicides will protect onions against these diseases.

Control Bulletins

- 58 Eleventh Annual Report on Eradication of Pullorum Disease in Massachusetts. H. Van Roekel. 24 pp. May, 1931.
 59 Inspection of Commercial Feedstuffs. Philip H. Smith. 49 pp. 1931.
 60 Inspection of Commercial Fertilizers. H. D. Haskins. 50 pp. December, 1931.
 61 Inspection of Agricultural Lime Products. H. D. Haskins and H. R. DeRose. 6 pp. December, 1931.

Meteorological Reports

- 505-516, inclusive. Monthly reports giving daily weather records, together with monthly and annual summaries. C. I. Gunness.

Reports of Investigation in Journals (Numbered Contributions)

- 108 Increase in Egg Weight during the Pullet Laying Year. F. A. Hays. Poultry Sci. Assoc. Proc. 1930.
 109 Linkage Relations between Genes for Egg Size and Genes Concerned in High Fecundity in Domestic Fowl. Frank A. Hays. Proc. World's Poultry Congress, 1930:134-138.
 110 Effect of the Structure and Moisture of Plant Containers on the Temperature of Their Soil Contents. Linus H. Jones. Jour. Agr. Research 42:375-378. March 15, 1931.
 112 Calcium Requirements of Dairy Heifers. J. B. Lindsey, J. G. Archibald, and P. R. Nelson. Jour. Agr. Research 42:883-896. June 15, 1931.
 113 Saprophytic and Secondary Microorganisms Occurring in the Respiratory Tracts of Domestic Fowls and Chickens in Health and Disease. Charles S. Gibbs. Jour. Bact. 21:97-109. February, 1931.
 114 Packed Heat from a New Type of Electric Steam Generator. Howard Bidwell and Linus H. Jones. Indus. and Engin. Chem. 23: March, 1931.
 115 Intensive Grassland Management. Richard C. Foley. Amer. Soc. Anim. Prod. Proc. 1930.

- 116 Further Evidence of a Potash-Lime Deficiency in a Sandy Loam Soil. J. K. Shaw. Amer. Soc. Hort. Sci. Proc. 1930:12-14.
- 117 Recent Developments in Nursery Variety Certification. J. K. Shaw. Amer. Soc. Hort. Sci. Proc. 1930:82-84.
- 118 Cost of Raising Pedigreed Pullets and Cockerels. F. A. Hays. Poultry Sci. 10:178-182. May 1, 1931.
- 119 The Relation of Temperature to Egg Production. J. C. Graham. Poultry Sci. Assoc. Proc. 1930.
- 120 The Assimilation of Nitrogen by Tobacco. A. B. Beaumont, G. J. Larsinos, P. Piekenbrock and P. R. Nelson. Jour. Agr. Research 43:559-567. September 15, 1931.

Other Contributions to Journals

(Unnumbered)

- Study Proves Glass Superior Container for Growing Plants. L. H. Jones. The Glass Container 10(5):12-41. March, 1931.
- Test Pots for House Plants. L. H. Jones. The Florists' Review (Chicago) 69 (1774):19-21. November 26, 1931.
- Insect Pests of Massachusetts Orchards in 1930. A. I. Bourne. Mass. Fruit Growers' Assoc. Rpt. 1931.
- Will Recommended Control Measures for Apple Maggot Work in Massachusetts? A. I. Bourne. Mass. Fruit Growers' Assoc. Rpt. 1931.
- A Test of Certain Spray Materials. O. C. Roberts and A. I. Bourne. Mass. Fruit Growers' Assoc. Rpt. 1931.
- Control of the Plum Curculio in Apple Orchards. W. D. Whitcomb. Conn. Pom. Soc. Rpt. December 1930.
- The Curculio and the Weather. W. D. Whitcomb. Mass. Fruit Growers' Assoc. Rpt. 1931.
- The Plum Curculio—An Apple Pest. W. D. Whitcomb. Fruits and Gardens 47:3-4. April, 1931.
- Control of Root Weevils on Taxus and Other Nursery Plants. W. D. Whitcomb. Natl. Nurseryman 39:5-6. June, 1931.
- Time—Temperature—Humidity Relations in Dried Fruit Pasteurization. J. A. Clague and C. R. Fellers. Jour. Bact. 20:30-31. January, 1931.
- Preservation of Sweet Cider. C. R. Fellers. Fruit Products Jour. 10:333-335; 374-375. July and August, 1931.

CHANGES IN STAFF, DECEMBER 1, 1930, TO NOVEMBER 30, 1931

Appointments

- Eisenmenger, Walter S., Ph.D., Research Professor in Agronomy, January 1, 1931.
- Isham, Paul D., B. S., Fellow in Horticultural Manufactures, December 27, 1930.
- Nagle, Margaret, Laboratory Assistant in Seed Law, February 1, 1931.
- Thigpen, James E., B. S., Research Assistant in Farm Management, September 1, 1931.
- Wait, Bernice C., Ph. D., Assistant Research Professor in Home Economics, September 22, 1931.
- Young, Robert E., M. S., Assistant Research Professor in Vegetable Gardening, June 1, 1931.
- Zinnoski, Felicia, Laboratory Assistant in Poultry Disease Control, September 1, 1931.

Resignations

Stuart, William M., M. S., Research Assistant in Agronomy, June 30, 1931.
Wright, Kenneth E., M. S., Assistant Research Professor in Dairying, September 15, 1931.

Deaths

Cutler, Walter L., Technical Assistant in Pomology, October 31, 1931.
Davies, Esther, Ph. B., Assistant Research Professor in Home Economics, July 12, 1931.

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MASSACHUSETTS
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AGRICULTURAL EXPERIMENT STATION

BULLETIN NO. 293

MARCH 1933

Annual Report

For the Fiscal Year Ending November 30, 1932

The main purpose of this report is to provide an opportunity for presenting in published form, recent results from experimentation in fields or on projects where progress has not been such as to justify the general and definite conclusions necessary to meet the requirements of bulletin or journal.

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MASSACHUSETTS AGRICULTURAL EXPERIMENT STATION STATE HOUSE BOSTON

Trustee Committee on Experiment Station

	Term Expires
PRESTON, CHARLES H., Hathorne, <i>Chairman</i>	1939
WHITMORE, PHILIP F., Sinderland	1934
RUSSELL, HOWARD S., Waltham	1936
FROST, HAROLD L., Arlington	1938
MALCOLM, DAVID J., Charlemont	1939
GILBERT, ARTHUR W., Belmont, <i>State Commissioner of Agriculture, ex officio</i>	

Experiment Station Staff, December, 1932

HUGH P. BAKER, President-elect of the College

SIEVERS, FRED J., Director	KENNEY, FRED C., Treasurer
LINDSEY, JOSEPH B., Vice-Director	CHURCH, LUCIA G., Secretary
GASKILL, EDWIN F., Assistant to the Director	

*BEAUMONT, ARTHUR B., Agronomy	JONES, LINUS H., Botany
BOURNE, ARTHUR L., Entomology	**KIGHTLINGER, C. V., Tobacco-Disease Investigations
*BRADLEY, LEON A., Bacteriology	KUZMESKI, JOHN W., Fertilizer Law
*CANCE, ALEXANDER E., Agricultural Economics	\$LARSONS, GEORGE J., Fertilizer Law
*CHENOWETH, WALTER W., Horticultural Manufacturers	MCLAUGHLIN, FREDERICK A., Seed Law
DORAN, WILLIAM L., Botany	MIGHILL, RONALD L., Farm Management
EISENMENGER, WALTER S., Agronomy	MUELLER, WILLIAM S., Dairy Industry
FELLERS, CARL R., Horticultural Manufacturers	ROZMAN, DAVID, Agricultural Economics
*FOORD, JAMES A., Farm Management	SPELMAN, ALBERT F., Feed Law
*FRANDSEN, JULIUS H., Dairy Industry	*WAIT, BERNICE C., Home Economics Research
†FRANKLIN, HENRY J., Cranberries	‡WHITCOMB, WARREN D., Entomology
*GASKILL, EDWIN F., Station Service	‡WHITE, HAROLD E., Floriculture
GIBBS, CHARLES S., Veterinary Science	YEGIAN, D. M., Veterinary Science
*GRAHAM, JOHN C., Poultry Husbandry	‡YOUNG, ROBERT E., Vegetable Gardening
*GUNNESS, CHRISTIAN I., Agricultural Engineering and Meteorology	ALLEN, HARRY L., Plant and Animal Chemistry
*HASKINS, HENRI D., Fertilizer Law	BALL, ALYN S., Botany
HAYS, FRANK A., Poultry Husbandry	BENNETT, EMMETT, Plant and Animal Chemistry
HOLLAND, EDWARD E., Plant and Animal Chemistry	CLAGUE, JOHN A., Horticultural Manufacturers
‡KOON, RAY M., Vegetable Gardening	CLARK, MIRIAM K., Veterinary Science
*LENTZ, JOHN B., Veterinary Science	CLEVELAND, MAURICE M., Horticultural Manufacturers
LINDSEY, ADRIAN H., Agricultural Economics	COWING, MADALINE V., Home Economics Research
*LINDSEY, JOSEPH B., Plant and Animal Chemistry	DARNELL, MATTHEW C., Agronomy
MORSE, FRED W., Plant and Animal Chemistry	DONLEY, J. ELIZABETH, Agricultural Economics
*OSMUN, A. VINCENT, Botany	‡DONNELLY, EDWARD B., Floriculture
*SEARS, FRED C., Pomology	HOWARD, JAMES T., Feed, Fertilizer and Dairy Laws
SHAW, JACOB K., Pomology	HUGHES, MARY C., Pomology
*SMITH, PHILIP H., Feed, Dairy and Seed Laws	ISHAM PAUL D., Horticultural Manufacturers
*THAYER, CLARK L., Floriculture	MERRIAM, OREANA A., Home Economics Research
VAN METER, RALPH A., Pomology	MINER, GLADYS I., Botany
‡VAN ROEKEL, HENRY, Veterinary Science	NAGLE, MARGARET E., Seed Law
*WOOD, BASIL B., Library	O'CONNER, MICHAEL G., Horticultural Manufacturers
ARCHIBALD, JOHN G., Plant and Animal Chemistry	PARKINSON, LEONARD R., Plant and Animal Chemistry
BAILEY, JOHN S., Pomology	ROBERTSON, DORIS W., Farm Management
*BERGMAN, HERBERT F., Cranberries	SANBORN, RUBY, Poultry Husbandry
BULLIS, KENNETH L., Veterinary Science	SHERBURNE, RUTH E., Agricultural Economics
DEROSE, H. ROBERT, Fertilizer Law	SMITH, ERNEST G., Horticultural Manufacturers
‡DEMPSEY, PAUL W., Vegetable Gardening	SNELL, MOSES E., Agronomy
FELTON, F. ETHEL, Editor	**TRURAN, WALTON E., Cranberries
FLINT, OLIVER S., Veterinary Science	‡WILSON, HAROLD A., Vegetable Gardening
FRANCE, RALPH L., Bacteriology	ZIMOSKI, FELICIA, Veterinary Science
FULLER, JAMES W., Bacteriology	
‡GUBA, EMIL F., Botany	
JEFFERSON, LORIAN P., Agricultural Economics	
JONES, CARLETON P., Plant and Animal Chemistry	

*In Charge †At East Wareham ‡At Waltham §On Leave **With U.S.D.A.

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CONTENTS

Introduction	4
Department Reports:	
Agricultural Economics.....	5
Agricultural Engineering.....	7
Agronomy.....	8
Bacteriology.....	13
Botany.....	15
The Cranberry Station.....	21
Dairy Industry.....	25
Entomology.....	28
Farm Management.....	34
Feed Control Service.....	36
Fertilizer Control Service.....	37
Floriculture.....	39
Home Economics.....	40
Horticultural Manufactures.....	41
Olericulture.....	43
Plant and Animal Chemistry.....	45
Pomology.....	48
Poultry Husbandry.....	54
Veterinary Science.....	56
Waltham Field Station.....	58
Cooperative Investigations:	
Cranberry.....	60
Tobacco.....	62
Publications.....	63

ANNUAL REPORT OF THE MASSACHUSETTS AGRICULTURAL EXPERIMENT STATION — 1932

INTRODUCTION

F. J. Sievers, Director

The year 1932 marks the fiftieth anniversary of the Massachusetts Agricultural Experiment Station which was provided for by legislative act and founded in 1882. In common with similar institutions established at about the same date in several other states, the Massachusetts Station has a history covering a half century of service to the American people. The influence of this service on the control of insect pests, the prevention and cure of plant and animal diseases, the better utilization of farm products, the more scientific management of soil, the more systematic and economic feeding and handling of plants and animals, and in general the better management of the entire farm has had a profound expression in the inauguration of greater efficiency in agriculture and therefore, indirectly, in all industry. Increased efficiency as a rule results in the establishment of a so-called higher standard of living and a consequent demand for products and services beyond those required for a bare existence. In agriculture it has resulted, also, in a decrease in the labor necessary to maintain the same volume of production, thus affording an opportunity for the employment of this released labor in other industries and thereby providing for the many so-called luxuries of which the automobile, radio, good roads, better housing and heating facilities, and more liberal provision for education are good examples. For the enjoyment of luxuries a certain amount of leisure is required, and fortunately for the American public, the demand for luxuries and the leisure and income necessary to enjoy them kept fairly uniform pace. Industry boomed, jobs were plentiful, confidence was abundant, and credit unexcelled. Recently, however, when these major factors, which require equilibrium for our successful operation, became unbalanced or disproportionate we experienced an upset in our entire social and economic structure, with the result that at present many of us find ourselves either with more leisure than we can afford, or with more luxuries than our income can support. This fundamental weakness in our social and economic relationships can be permanently corrected only by recognizing the basic causes and dealing with them boldly and without fear or prejudice. This country is adequately supplied, yes, if not over-supplied, with all of the essentials of life. There is no universal lack of food, clothing, shelter, and, last but not least, of human energy ready and willing to apply itself. It is quite generally agreed that we suffer as individuals because of inadequate distribution of an abundant supply of these essentials. Food is not available where hunger exists. Clothing and good shelter are not accessible to those suffering from exposure. But most fundamental of all is the lack of proper distribution of labor or of the opportunity for all willing workers to make a living. To right this condition requires not only courageous research, but a program free from bias.

Of all agencies organized for public service there is none which should be better equipped as regards experienced personnel than the agricultural experiment stations. These institutions, because of their habit and experience in approaching without partiality problems requiring research, and also because of their record

of achievement in fields to which their energies have been directed in the past, should qualify to give aid in the development of a solution for our present problems of depression. There are already evidences that a constructive program based on research is desired. It is not unreasonable to assume that the general public is ready to place the same confidence in results gained by experiment stations in this field that the farmer has, in discoveries in the field of Agriculture. It is a project worthy of our foremost consideration.

DEPARTMENT OF AGRICULTURAL ECONOMICS

Alexander E. Cance in Charge

Factors Affecting the Price of Eggs. (A. H. Lindsey.) Revised correlation analysis shows that the price level is the most important factor affecting the annual average price of eggs. For nearby eggs the annual average price decreases 5.68 cents for each 10-point decline in Snyder's index of price level. An increase of 100,000 cases in Boston receipts lowers prices 1.5 cents. For western eggs in the Boston market a 10-point decline in price level lowers the price 4.95 cents, and an increase of 100,000 cases in receipts lowers the price for this grade 1.4 cents.

Further refinement of the influence of various factors at different periods of the year is being carried on covering 12 years of data instead of the original shorter period of 6 years.

Forecasting devices worked out for estimating April average prices from January 1 and for estimating November average prices from June 1 have been found to predict future prices quite accurately.

Work similar to the study of egg prices has been started on factors affecting prices of live and dressed poultry.

Competitive Factors Influencing the Supply of Market Milk and Cream. (A. H. Lindsey.) A survey was completed of milk supplies in all important secondary markets outside of the Boston Metropolitan area. Information was obtained as to percentage of Massachusetts supply, consumption of grade A and pasteurized milk, price conditions, and policies in closed and open markets.

Some time was spent in gathering data from several milk distributors in or near Worcester. For the five distributors visited, preliminary figures on daily milk consumption for the month of April are as follows:

1928		1930		1932	
Number of Families	Quarts	Number of Families	Quarts	Number of Families	Quarts
229	350	322	506	377	548
1,494	1,939	1,822	2,380	1,569	2,133
.....		994	1,367	1,245	1,714
2,003	2,768	2,153	2,821	2,134	2,906
1,284	1,790	1,841	2,563	2,468	3,312
5,010	6,847	7,132	9,637	7,793	10,613
Average per family per day			1.35		1.36
	1.37				

Shipping Massachusetts Apples. (A. H. Lindsey and A. A. Brown.) This investigation was initiated with the realization that the production of apples in Massachusetts is increasing at such a rate that within a few years Massachusetts

growers must depend on other than local markets. It was desired that the study should bring out the best methods of putting the apples on the more distant markets. The largest apple shippers in the State were visited in the survey. The experiences of these men in shipping apples were studied in detail; such as the comparative advantage of rail and truck shipments, packaging, grading, and methods of contract with motor carriers. Case studies were made of freight bills and of many cases in which legitimate and illegitimate charges were made against the grower or shipper. The reports show that considerable saving could be made by proper routing, and a knowledge of freight tariffs and tariff rules. It is intended to carry on further investigation of the markets next fall.

Recreational and Forestry Uses of Land. (David Rozman.) This project has been completed and the manuscript presented for publication. It points out the place of recreational and forestry uses of land in working out a balanced program of land utilization for the Commonwealth. The investigation indicates that, largely as a result of the abandonment of farm land, about one-third of the total area in towns with a population of less than 10,000 is owned by non-residents. In the towns situated near the coast and in some inland towns the land owned by non-residents is utilized to a great extent for recreational purposes. However, most of the abandoned farm land held by non-residents is represented by idle acres covered with brush and inferior woods. Although the indications are that a considerable amount of the present area of idle land will be taken in the near future for part-time farming and recreational uses, the major part of it will have to be devoted to the growing of trees under the control of both public institutions and private owners.

Marketing of Milk Secondary in Markets of Massachusetts. (David Rozman.) This study, initiated in the spring of 1932, deals with the analysis of marketing problems arising largely from changing conditions of milk supply in secondary markets of Massachusetts. The field work was carried on last summer in three cities situated outside of the Metropolitan area of Boston: Gardner in Worcester County, Attleboro in Bristol County, and Newburyport in Essex County. The data obtained in these cities include information on sources of milk supply and condition of marketing machinery, covering the practices and price plans of producers, distributors, dealers, cooperative organizations, and other distributing agencies.

Consumer Demand for Eggs. (Lorian P. Jefferson.) This project is nearing completion. Much of the tabulation is done, and a considerable portion is in manuscript form.

Changing Methods of Wholesale Distribution of Perishables. (Lorian P. Jefferson.) This project becomes increasingly more timely as distributors continue to seek better and less costly methods of marketing perishables and as new distributing agencies enter the field. It is evident that a process of decentralization is taking place in many places and in particular products. The warehousing of chain-store products is becoming a matter of districts, rather than states or larger regions. The Atlantic and Pacific chain, for example, now maintains several more warehouses in New England than formerly. The wholesale distribution of meat in Boston shows this tendency to decentralization, there being now several points at which meats are received and distributed.

Changes include certain new methods of handling credit and different methods of payment for goods. The growing importance of the traveling jobber, trucker, itinerant jobber, peddler — all these names being applied to the same agent —

is one of the outstanding features of the changes taking place in distribution. This is characteristic of no particular section of the country, and many are the efforts on the part of wholesalers and regular jobbers to control or eliminate this competition with their business. New England wholesalers seem not to suffer greatly from one aspect of this method that is found in other sections, where the traveling jobber buys directly from the grower and sells the product in the market where it would otherwise have been handled by the regular trade.

These aspects of the problem have received some attention, but all must have further investigation.

Analysis of Market Prices for Massachusetts Vegetables. (H. B. Rowe.) This project, begun in 1930, includes the analysis of annual and weekly variations in prices for eight leading vegetables on the Boston market: asparagus, cabbage, carrots, celery, cucumbers, spinach, squash, and tomatoes. Daily price and supply data have been tabulated for the ten-year period 1922-1931. From these data annual and weekly series have been compiled. Conventional methods of price analysis have been used in isolating and measuring the most important relationships explaining price variations. The study has now been practically completed through these stages for each vegetable except cabbage and cucumbers, on which some further analysis is required. A beginning also has been made in preparing the results for publication.

Results include the determination of fairly reliable relationships between prices, supply, and seasonal variation in demand for asparagus, bunched and cut carrots, Pascal and white celery, spring spinach, squash, winter and summer greenhouse tomatoes, and field tomatoes. For each of these products the analysis has furnished a very good explanation of the principal price variations which have occurred during the period included in the study. Also it has been possible to measure the relative importance of receipts from local farms and carlot arrivals as price determinants. In general, local supplies and trend have been the most important factors influencing year to year variations in prices for these products during the period since 1922. Likewise, supplies from local sources and normal seasonal changes account for the major price variations within the season. These relationships appear to have remained practically unchanged throughout the period. In the case of summer and fall spinach, results have been mostly negative in character, apparently due to the wide range of quality covered by available quotations. Results obtained from the project thus far contribute materially to an understanding of the market situation for the vegetable-producing industry of Massachusetts, since they provide definite information regarding price movements and their causes. Such knowledge permits a more reliable interpretation of current market developments by producers as a basis for production and marketing plans. Furthermore it gives a more dependable basis for outlook work and shows the more important items which should be covered in current market reports.

DEPARTMENT OF AGRICULTURAL ENGINEERING

C. I. Gunness in Charge

Investigation of Apple Storages. (C. I. Gunness.) A study of the effect of humidity on evaporation from apples in storage at various temperatures was started in the fall of 1931. Based on the first year's operation, it is apparent that humidities of 70 and 75 per cent cause considerably more evaporation than a humidity of 88 per cent at all temperatures. It was found, however, that the

difference in rate of evaporation at various humidities was greater at high temperatures. The study is being continued during the present season in an attempt to narrow the range of humidities used and determine the lowest humidity which can be safely used without causing shriveling.

Fertilizer Distributors. (C. I. Gunness.) A fertilizer attachment was developed for a tobacco transplanter, which would apply the relatively large amount of fertilizer used in the Connecticut Valley and place the fertilizer in bands on both sides of the row of plants. Tobacco was planted with fertilizer applied at different depths and different distances from the row in a test carried out and reported by the Department of Agronomy.

Test of Low-Lift Pumps. (C. I. Gunness.) Additional pumps were tested at the Cranberry Station during the past season. The result of the tests made during the past three years will be published at an early date.

DEPARTMENT OF AGRONOMY

A. B. Beaumont in Charge

Pasture Experiments. (A. B. Beaumont and E. F. Gaskill.) Experiments in the improvement of upland pastures by top-dressing with fertilizers have been continued. The results of 1932 are in general accord with those reported in recent years and summarized in Bulletin 282 published recently.

Work is in progress on the question of form of nitrogen best suited to our pasture conditions. Indications to date are that nitrates, ammonium salts, urea, and calcium cyanamid can each be used advantageously under certain conditions. Experiments with cyanamid have shown that when it is applied in amounts above 200 pounds per acre, a more or less transitory "burn" of grasses and clovers occurs, regardless of the season of the year when applied; but this effect is not considered a sufficient reason for not using this material.

Legume Variety Tests. (J. L. Haddock, A. B. Beaumont and M. C. Darnell, in cooperation with Division Forage Crops and Diseases, Bureau of Plant Industry, U.S.D.A.)

Alfalfa. The highest-yielding varieties for 1932 were as follows:

1929 seeding: Hardigan (4.91 tons), Kansas, Arizona, Utah, and Ontario.

1930 seeding: New Mexico (4.75 tons), South African, California, Argentine, and Oklahoma.

1931 seeding: Hardigan (4.63 tons), Argentine (4.63 tons), New Mexico (19010), New Mexico (19011), and Grimm.

Red Clover. Nineteen strains of red clover were seeded in 1931, and two cuttings were harvested in 1932. The results were similar to those reported last year; namely, that the northern-grown American strains outyielded the European. Tennessee (19002) gave the highest yield (3.10 tons).

Vetch. In the test seeded in the fall of 1931 with rye as a companion crop, the highest yield of vetch alone was from Smooth (0.702 tons), followed in order by Oregon Hairy, Common Hairy, Hungarian, and Oregon Common. In the 1932 spring seeding with oats, the best yield of vetch alone was from Smooth (1.07 tons), followed by Oregon Pearl, Common Hairy, Hungarian, and Oregon Common.

Field Peas. Peas were seeded with oats as a companion crop in 1932. Golden Vine gave the best yield (0.807 tons) of peas alone, followed in order by Chang, O.A.C. 181, Multiplier, Common, and Austrian Winter.

Soy Beans. In the test of 1932, several of the varieties which gave low yields in previous years were discarded as being unsuitable for forage under conditions here. Some new varieties were included in the test. The highest-yielding 10 varieties were: Mukden (new 1932) (2.59 tons hay), Wea, F.P.I. 50536 (new 1932), F.P.I. 63242-2 (new 1932), Dunfield, Harbinsoy, Manchu, F. C. 03654-A, Mansoy, F.P.I. 53933-3B (2.33 tons). Rows were 36 inches apart in 1932, 30 inches in previous years.

Field Experiments with Onions. (M. E. Snell and A. B. Beaumont.)

Fertilizer ratios. The field experiments with lime and fertilizer ratios were continued with no radical changes. This completes three years' records with onion sets, which have proved better adapted to the work than seed onions. The past season, the 4-12-8 (organic) and the 4-12-4 ratios (these figures refer to percentage of NH_3 , P_2O_5 , and K_2O) were the only ones which yielded higher than their 4-8-4 check plots. The 6-8-8, 4-8-8, 4-12-8 (inorganic), and the 2-12-8 ratios were again poorer than their check plots.

Over the three-year period the 4-12-4, 4-12-8 (organic), and the 4-8-4 (with 2-0-0 nitrate top-dressing) gave slightly higher yields than their 4-8-4 check plots. The 6-8-8, 2-12-8, 4-8-8, and 4-12-8 (inorganic) were all inferior to their check plots. The 6-8-4, 8-16-8, and 4-7-4 (with 2-1-0 fish top-dressing) were about equal to their check plots. Application of lime, in excess of three tons, gave an increase in yield of 5 to 10 per cent for the three-year period. When the lime was withheld and the phosphorus doubled with a 4-8-4 and a 4-12-4, the yield was increased about 10 per cent. When 600 pounds per acre or 1200 pounds per acre of superphosphate were supplied in addition to the 4-8-4, and lime was applied annually for five years at the rate of 1000 pounds per acre instead of in three 1-ton applications over a period of seven years, the increase was 21 and 27 per cent respectively. However, the same applications of superphosphate applied with 500 pounds of lime annually, gave but slight increase over the three 1-ton applications without the extra superphosphate.

Onion set experiment. Last year some preliminary work was done in an attempt to determine methods of getting maximum yields of a desired size of set for planting. Also, the effect of the conditions under which they were grown on the keeping quality of the sets was studied. In these tests 50 pounds of seed per acre, 500 pounds per acre of a 4-12-8 fertilizer, and seed distributed over a two-inch-wide row proved the most satisfactory of the rates tried. The most desirable size of set, 1/2 to 3/4 inch, showed least loss in storage from sprouting, decay, and moisture loss. This size sprouted less than the largest size and decayed less than the smallest two sizes. The lighter seedings and the wider rows showed less loss than the heavier seedings and narrower rows. There was little decay where 500 pounds per acre of a 4-12-8 fertilizer were used.

During the past season more extensive work was done. Four fertilizer levels were used; namely, 500 pounds per acre of a 0-12-8, 2-12-8, and 4-12-8, and 1000 pounds of a 4-12-8. The rates of seeding were 30, 40, and 50 pounds per acre, and the seed was distributed over one-, two-, and three-inch-wide rows with the 500 pounds per acre of the 4-12-8 fertilizer; but two-inch rows were used on all other fertilizer treatments. It was again clearly shown that there is a balance between the food supply and the population, which must be maintained in order to produce maximum yields having a high percentage of a desired size. Forty pounds of seed per acre were adequate with 500 pounds of the 2-12-8, but 50 pounds were needed with 500 pounds of the 4-12-8; 1000 pounds per acre of the 4-12-8, even with a high rate of seeding, supplied too much plant food for a good crop of sets. Five hun-

dred pounds of the 0-12-8 did not give a high yield of either total sets or sets of the desired size; but gave a very high percentage of sets of the desired size, especially with 30 and 40 pounds of seed per acre. In general, 30 pounds of seed per acre were not enough for best results, and the three-inch rows seemed to give better opportunity for development than the narrower rows. Several of the plots yielded over 12,000 pounds per acre of sets of the 1/2- to 3/4-inch size.

Onion Breeding. (M. E. Snell.) This project was continued during the past summer as previously, except for one change in technique. Previously two types of inbreeding had been used. In one, designated as "mass fertilized," all bulbs of each selection were planted close together and just before flowering were surrounded by a netting-covered frame which permitted fertilization among bulbs of the same strain. In the other, known as "self fertilized," each flower head was given a separate covering. Since the two methods seemed to give very similar results, and the former was the more expensive, it has been discontinued.

The seed from the inbred strains, which were crossed a year ago was planted, and a few more cross-matings were made this year. A good crop of bulbs was produced and is being housed in the new storage which was recently completed. This storage should greatly facilitate the work by permitting bulbs to be carried over for breeding purposes, which was not possible with the former facilities.

Field Experiments with Tobacco. (A. B. Beaumont and M. E. Snell.)

Cropping systems. Results of eight years (1924-1931) of experiments on the effect of cropping systems on the yield and quality of tobacco have been summarized for publication in bulletin form. Cover crops were in general beneficial. Of those studied, red top (*Agrostis alba*) was the most, and timothy (*Phleum pratense*) the least beneficial. The highest yield was produced where tobacco was grown continuously with fertilizer and a cover crop of red top, but the best quality of tobacco was produced where manure was used as a supplement to the fertilizer. Tobacco grown in rotation with other crops was low in yield and poor in quality.

In the season of 1932 some changes were made in the cropping systems, including the substitution of oats for rye as a cover crop. The concentration of the nitrogen in the fertilizer used was raised from 4.1 per cent (used 1924-1931) to 5.0 per cent. Red top cover again produced the highest yield (1907 pounds) of all cover crops used, but was slightly surpassed by the manure supplement with no cover. In comparison with no-cover (check) plots, oats, timothy, and rye cover crops depressed the yield in the order given. The yield from the rotation plots was of the same low order as in previous years. The addition of sodium nitrate and calcium nitrate to certain rows of tobacco in the rotation plots did not increase yield but did raise the nitrate content of the soil to a high point. The addition of dried peat in a similar way increased the yield of tobacco.

Form of nitrogen. The old experiment on single forms of nitrogen was modified in 1932. One half the fertilizer nitrogen was supplied from cottonseed meal and the other half from each of the following carriers: sodium nitrate, ammonium sulfate, urea, and calcium cyanamid. The standard fertilizer mixture containing nitrogen from cottonseed meal, sodium nitrate, and calurea was used as a check. In case of tobacco following tobacco, calcium cyanamid and the standard mixture produced the highest yields, followed closely by ammonium sulfate, urea, and sodium nitrate; but after timothy cover or sod, the order was standard mixture (highest), ammonium sulfate, urea, sodium nitrate, and calcium cyanamid.

A new experiment on different proportions of organic and inorganic nitrogen

for tobacco was started in 1932. The organic nitrogen was supplied by cotton-seed meal, and the inorganic nitrogen by a mixture of equal parts of sodium nitrate and ammonium sulfate. The fractions of organic nitrogen were 1/8, 2/8, 3/8 and 4/8 of the whole. Comparison was made with the standard mixture. The highest yield (1954 pounds) was obtained with 1/8 organic nitrogen and 7/8 inorganic, followed by 4/8, 3/8 and 2/8 organic. All mixtures yielded more than the standard mixture. Since organic nitrogen is generally assumed to have an especially favorable influence on quality of tobacco, it will be necessary to await the sorting records for these treatments before they can be properly evaluated.

The experiment on different total amounts of nitrogen was discontinued in 1932.

Method of applying fertilizer. Prof. C. I. Gunness of the Agricultural Engineering Department modified the transplanting machine used in these experiments so that fertilizer could be placed by the machine at the time of setting tobacco. The fertilizer was placed in bands 3 inches wide at each side of the plant and 1 inch from it. The standard broadcast application of 3500 pounds per acre was compared with machine application of 4/8, 5/8 and 6/8 of the standard amount of fertilizer. The average yields of tobacco (pounds per acre) were as follows:

	Machine Application		Broadcast (Check)
4/8 Standard application.....	1846	Standard application.....	1822
5/8 Standard application.....	1732	Standard application.....	1855
6/8 Standard application.....	1861	Standard application.....	1881

Comparable experiments were conducted on several private farms of the vicinity. Results obtained thus far from these experiments are similar to those obtained on the station plots. On account of the possible residual effect of fertilizers used in previous years, it will be necessary to continue this experiment several years on the same field.

Distribution of Nitrogen in the Tobacco Plant. (W. S. Eisenmenger.) Tobacco plants were grown in nutrient solutions for about one month. They were then divided into four groups of fifty plants each. Two groups received the same complete nutrient solution — one growing in normal light, the other growing in complete darkness. From the other two groups nitrogen was withheld — one in the light, the other in darkness. The plants were continued thus for eleven days. At the end of this period all were harvested and divided into roots, stems, mid vein and residual leaf portion. They were kept frozen until they were analyzed for total and water soluble nitrogen, α -amino acids, ammonia, amides, protein, peptid, humin, and nitrate nitrogen. The results indicated that much of the nitrate is reduced in the aerial portion of the plant, at or near the mid vein. Darkness increased the nitrate and α -amino acid in the plants and decreased the leaf weight. Withholding nitrogen lowered the dry weight of roots and stem.

The results of this investigation have been accepted for publication in the *Journal of Agricultural Research*.

Toxicity of Aluminum for Tobacco. (W. S. Eisenmenger.) Tobacco plants were grown in nutrient solutions for slightly less than two months. The solutions were renewed every second day. For two days they grew in a complete nutrient solution (Knop's), and on the succeeding two days the solution was the same except that phosphates were withheld and aluminum citrate was added in varying concentrations — 0, 2, 5, 15, 30, 50, 70, 85, 95, 98, and 100 per cent of .006 Mol. Definite toxicity effects were indicated in the dry weights of top and roots.

Similar toxicity effects are being determined for the seedling stage of soy beans,

corn and buckwheat in single-salt solutions. Also the ameliorating effects of Ca, K, OH and Mg ions in separate cultures are noted.

Magnesium Requirement of Crops. (A. B. Beaumont and M. E. Snell.) The crops grown in the field in 1932 were alsike clover, buckwheat, soy beans, corn, and oats. Oats on magnesium-deficient plots exhibited a marked chlorosis of intervenous leaf tissue in the early stages of growth, but lost this symptom in later stages. Buckwheat and corn developed mottled chlorotic leaves in the late-growth stages. Only in case of buckwheat was the yield better on plots which received magnesium sulfate than on magnesium-deficient plots.

Top-dressing Grasslands with Fertilizers. (A. B. Beaumont and M. E. Snell.)

Fertilizer ratios. This experiment was expanded in 1932 to include a wider range of ratios. In both the old and the new portions of the experiment the results show a definite response to increments of potash only. The highest yield was from fertilizer having a ratio of 3:3:8 (N:P₂O₅:K₂O). High nitrogen failed to rank as high as in the past four years, probably because a second cutting could not be made on account of the drought of the latter part of the summer.

Forms of nitrogen. In a new experiment in the top-dressing of an old mowing (meadow) with different commercial forms of nitrogen, the highest yield was obtained from nitrate of soda, followed by ammonium sulfate, urea, and calcium cyanamid in order. Here, again, on account of dry weather no second cutting was available, and this may have affected the order of the results.

Assimilation of Fixed Nitrogen by Grasses and Clovers. (A. B. Beaumont, W. S. Eisenmenger and W. J. Moore.) Five species of grasses and clovers used for forage were grown in sterilized and unsterilized solution cultures which contained sodium nitrate, ammonium sulfate, or urea in addition to the requisite minerals. From the weight of dry matter produced and from the chemical composition, it was concluded that nitrogen was assimilated most completely in the form of nitrate by the grasses, and in the form of urea by the clovers. In the later stages of growth, ammonium sulfate and urea became toxic to both grasses and clover. In the unsterilized cultures the roots became dark and decayed, but in the sterilized cultures they remained white and sound. In explanation of the darkening and decay of the roots, the narrowing of the C-N ratio by the accumulation of unassimilated nitrogen in the roots is suggested. The addition of calcium carbonate to the ammonium sulfate solution maintained the reaction near the neutral point, but this did not prevent the injurious action on the roots, nor did it materially increase the growth of the plant and the assimilation of nitrogen.

Nitrification of Castor Pomace, Soy Bean Meal, and Other Organic Materials. (M. H. Cubbon.) Nitrate nitrogen accumulation in an acid soil of low fertility as influenced by the above materials was studied in the laboratory over a three-month period. Readings were taken at 10-day intervals. The nitrogen content of the castor pomace samples varied from 4.36 to 5.80 per cent. In three months' time 75 to 100 per cent of the nitrogen in castor pomace and soy bean meal was nitrified. High oil content (10.24 per cent in castor pomace and 18.62 per cent in soy bean meal) slightly hindered but did not prevent nitrate accumulation. Nearly half the nitrogen in such organic materials as peanut shell meal, garbage tankage, ground peat, "soil sponge," and "hyper humus" changed to nitrate in three months. Peanut shell meal caused a decided depression of nitrates for the first month. Nitrate accumulation from sulfate of ammonia proceeded at average level after the first month. Apparently a month is necessary in this soil for nitrate accumulation to be noticeable.

Effect of Varying Amounts of Moisture and Organic Materials on Soil Nitrates. (M. H. Cubbon.) Nitrate nitrogen was produced in large quantities in potted soils which had been treated with different (and large) amounts of domestic peat and manure. The moisture content was purposely varied in different pots. Nitrates increased with increase of moisture up to about 35 per cent. Nitrate nitrogen disappeared from the soil, or was greatly reduced, when turnips began to grow vigorously. Soils which received excessive amounts of manure (80 tons), or peat equivalent to 20 tons of manure, maintained a relatively high nitrate nitrogen content throughout the growing season. (This is part of a study of factors affecting "dark center" of turnips, in cooperation with the Department of Olericulture.)

Fine Turf Grasses. (L. S. Dickinson.) Further studies have been made regarding the desirability of pre-seeding fertilization of newly built or newly seeded turf areas, and a check experiment has been conducted to verify the results obtained in 1931. Nitrogen, phosphorus, and potash were applied singly and in combinations prior to seeding with Kentucky bluegrass and Colonial bent. The check experiments were conducted in deep boxes, placed out of doors and unprotected. The results obtained again indicate that on normal soils pre-seeding fertilization with anything but superphosphate or a single phosphorus carrier is unnecessary. Also, that stronger young plants are obtained without pre-seeding nitrogen and potash, and that the plants will more economically use fertilizer applied as a top-dressing when they are from 60 to 70 days old. This project was made possible by the New England Greenkeepers' Association.

The plots maintained in cooperation with the United States Golf Association, and the nine-year-old lawn plots on one of the regular campus lawn areas, are the only plots that are now being maintained, due to the decrease in funds.

A new project, made possible by Brague Inc., has been started to determine the advisable amounts of peat to be mixed with various types of soil to improve the physical condition. This involves a study of methods of determining, easily and quickly, yet with practical reliability, the physical strength of soil samples. A study is being made, also, of methods of establishing definite soil standards to use in comparative work.

DEPARTMENT OF BACTERIOLOGY

Leon A. Bradley in Charge

Nitrogen Fixation in the Presence of or as a Result of Legumes Versus Non-Legumes. (J. E. Fuller.) Additional studies have been made to determine the activity of nitrification and carbon-dioxide evolution, for the purpose of comparing these activities with nitrogen fixation in the same field in which previous studies have been made. Dried blood and ammonium sulfate respectively were added to the soil, and the rate of nitrification of these substances was determined. Carbon-dioxide evolution was determined from soil samples to which oat straw had been added. All of the experiments were carried out in pots in the laboratory. The soil samples studied represented two lots, one lot having been collected before the field was plowed in the spring, and the other in the fall after the crops had been harvested. No influence was observed, on the part of the legume crop as compared with the non-legume crop, on nitrification or cellulose decomposition. A paper describing the study in detail has been accepted for publication in *Soil Science*.

Influence of Temperature on the Nitrate Content of Soil in the Presence of Decomposing Cellulose. (J. E. Fuller and L. H. Jones.) This study was

carried out in cooperation with the Department of Botany. The results of the experiments have been published (*Soil Science* 34:337-351, 1932), and reference may be made to the published paper for details of the study.

Application of the Soil Plaque Method for Determining Mineral Deficiencies in Massachusetts Soils. (J. E. Fuller.) The method depends on the growth of *Azotobacter* as an indicator of the presence in the soil of minerals essential to the growth of crops. The results obtained from the soils studied indicated that the method cannot be depended upon for determining the deficiency of available phosphorus under the conditions existing in the field from which the samples were taken. It was observed that the soils did not contain sufficient phosphorus to support *Azotobacter* growth, even though the field from which the samples were taken had produced satisfactory crops. Further studies are being made with soil samples collected from more widely distributed areas.

Bacteriological Studies of Dried Milk Powders. (J. E. Fuller and R. L. France.) Several samples of dried milk powder were examined for the presence of the tubercle bacillus in order to determine the safety of the powder for feeding calves. Some of the samples were from milk powder dried by the roller process; others, from milk powder dried by the spray process. The latter, being easily soluble in water, were made into solution and inoculated into guinea pigs. The animals of this group were observed for a month and then killed. The milk powder dried by the roller process was only partially soluble in water, so the powder was mixed with other food and fed to guinea pigs. The animals of this group were observed for two months and then killed. Both groups of guinea pigs appeared to be healthy throughout the periods of observation. The weights of all of the animals showed gradual increase. Autopsies did not show any evidence of tubercular infection in any of the animals. The experiments indicated that the milk powders studied did not contain tubercle bacilli. These results agreed with those obtained by other investigators.

Udder Infection in a Cow. (J. E. Fuller and R. L. France.) The udder infection studied occurred in a cow of the experiment station herd. An organism was isolated from the milk and also from the udder when the cow was killed.

The blood serum of the cow agglutinated the organism to a titer of 1 to 1,280. The study will be reported more in detail at a later date.

Laboratory Service. (R. L. France.) Following is a list of the number and types of examinations made by the laboratory during the past year:

Milk (bacteria counts).....	1,160
Water analysis.....	123
Miscellaneous:	
*Butter fat.....	197
*Milk solids.....	7
Baby foods.....	12
Throat swabs.....	10
Chlorine.....	4
Yeast.....	2
Powdered milk.....	1
Anaerobes.....	1
Food poisoning.....	1
TOTAL.....	1,518

*Analysis made by P. H. Smith, Feed Control Laboratory.

This is an increase of 270 examinations over the previous year, due mostly to bacterial and chemical examinations of milk. This phase of the service has increased yearly, and the laboratory is providing a valuable service to milk producers, dairymen and local health inspectors throughout the Valley.

The number of water analyses has shown a decrease during the past year. This is probably due to the fact that the laboratory is unable to make a sanitary survey of the supplies examined. Without this survey it is impossible to offer constructive suggestions in the care of polluted supplies.

The stock of legume cultures has been kept intact and these were furnished to farmers requesting them for inoculation of leguminous plants.

Upon request of the Horticultural Manufactures Department bacterial examination of samples of a new baby food were made.

Bacterial counts of milk samples held under different cooling methods were made for the Dairy Department.

The Indol Tolerance of the Colon-Aerogenes Group of Bacteria as a Possible Means of Differentiating Fecal and Non-Fecal Strains Occurring in Drinking-Water Supplies. (R. L. France.) Preliminary work on this project has been completed and accepted for publication in the *Journal of Bacteriology* under the title, "Bacterium coli in rural privately owned water supplies."

The results obtained in this investigation suggest that dependence on the Standard Methods procedure alone for determining the sanitary quality of drinking water, especially from privately owned supplies of unknown history, results in too many of the samples being condemned. The need of supplementary differential tests is indicated, but results do not justify the recommendation of any particular test or group of tests.

In an effort to derive a satisfactory test, work is being done to determine the indol tolerance of strains of the Colon-aerogenes group of bacteria. Results to date do not justify any statement regarding sharp differences among strains.

DEPARTMENT OF BOTANY

A. Vincent Osmun in Charge

Black Root-Rot of Tobacco. (W. L. Doran.) Tobacco was grown for the tenth successive year in plots last limed in 1923. In 1932, there was no black root-rot in plots not limed, the soil of which has a pH value of 5.2, but the disease was moderately severe in adjacent limed plots, the soil of which has a pH value of 5.9. The average yields of tobacco per acre in 1932 were 1906 pounds in plots not limed and 1559 pounds, or 18 per cent less, in plots limed. The persistence of the effects of lime on black root-rot and yields of tobacco is indicated by the fact that, with lime last applied in 1923, loss in yield in limed plots (as compared with yield in plots not limed) has been as follows: 10 per cent in 1924, 45 per cent in 1925, 43 per cent in 1926, 35 per cent in 1927, 23 per cent in 1929, 25 per cent in 1930, 16 per cent in 1931, and 18 per cent in 1932. The sorting record of the crop of 1931 (the latest crop sorted) showed that lime applied in 1923 was still resulting in impaired quality as well as reduced yields. The fire-holding capacity of the crop of 1931 was not injured by lime, however.

In pot experiments, infection of tobacco by *Thielavia basicola* (Berk. and Br.) Zopf was much reduced or, more often, entirely prevented by ammonium thiocyanate applied to soil at the rate of 900 pounds per acre. This rate of application was as effective in preventing infection as were heavier applications. It resulted, however, in soil toxic to tobacco for 18 weeks, although not for 25 weeks, after

treatment. The length of time toxicity persisted was not shortened by the supplementary use of ferric chloride.

Calcium cyanide applied to soil at rates up to 1800 pounds per acre did not prevent infection of tobacco by *Thielavia*. Heavier applications reduced the severity of infection without increasing soil acidity, but were toxic to plants.

Brown Root-Rot of Tobacco. (W. L. Doran.) When this disease developed following timothy in a cropping system, it was usually more severe in clay soils than in sandy soils. The addition of timothy to a soil was sometimes beneficial to tobacco, the benefit being greater in sandy soils than in clay soils. In general, timothy when followed by brown root-rot of tobacco was less harmful in sandy than in clay soils; and timothy when it did not result in brown root-rot of tobacco was followed by better growth of tobacco in sandy than in clay soils.

Disease Resistance of Potato Varieties. (W. L. Doran.) The varieties Green Mountain, Katahdin, and Foster's Rust-proof were compared. There was no late-blight and there was little or none of the virus diseases. The season was dry and there was much injury of Green Mountain and Katahdin by drought, tip burn, and insects (aphis and leafhopper). Under these conditions, Foster's Rust-proof was much more resistant and long-lived than either Green Mountain or Katahdin.

Downy Mildews of Cucumbers and Lettuce. (W. L. Doran.) Downy mildew of cucumbers (*Peronoplasmodium cubensis* (B. & C.) Clint.) was not observed here in 1931, but it appeared on August 18 in 1932. This is the latest recorded date of its first appearance here in any year. An account of investigations of this disease by the writer has been published recently in Bulletin 283.

It was found that resin has a markedly fungicidal effect on *P. cubensis*. A stock solution was made of resin 5 parts, wood alcohol 5 parts, and potassium hydroxide 1 part. This was then diluted with water so as to contain resin in the proportions indicated below. Infection of cucumber plants, sprayed with resin solutions previous to inoculating with *P. cubensis*, was entirely prevented by resin 1:150 and reduced to only a trace by resin 1:200. There was no injury to cucumber plants by resin 1:150, although they were slightly injured by resin 1:100.

Downy mildew of lettuce (*Bremia lactucae* E. Regel) was severe on the variety Bel-May in greenhouses in April 1932, although this variety had been previously considered relatively resistant.

The resistance of certain varieties of lettuce was shown by the average number of plants which became infected out of each 100 plants inoculated with *B. lactucae*. These were as follows: Dreer's Wonderful, 25; Sutton's Golden Ball, 24; Rosy Spring, 3; Dreer's Iceberg, 1; Loos Tennis Ball, 0; Loos Tennis Ball (Vilmorin's), 0.

Germination of the conidia of this fungus was prevented when the conidia, in water, were placed on micro-slides which had been sprayed with resin 1:100. A 0.25 per cent solution of sodium tetraborate (borax) similarly used was likewise effective in preventing germination. Anhydrous sodium carbonate was ineffective at the concentrations used.

With over 90 per cent of these conidia germinating in water, less than 10 per cent germinated in a 1 per cent water solution of the exudate from cut stems of lettuce plants.

Spore germination of *B. lactucae* was entirely prevented by dusting infected plants with sulfur dust. Copper-lime-arsenic dust was nearly as effective.

Eggplant Wilt. (E. F. Guba, Waltham.) Growth of *Verticillium* in culture occurred at a range of 50°-95° F., with the optimum at 78°. The best growth of

eggplant occurred at a soil temperature range of 77°-95° F., and most infection at 77°. No infection occurred at soil temperatures of 55.4° and 95° F.

When aluminum sulfate was used to acidify the soil, no infection occurred at pH values below 5.0; and when inoculated sulfur was used, there was slight infection at pH 4.0-4.2. Aluminum sulfate gave more consistent control of wilt at the low values than sulfur.

Results of field applications of aluminum sulfate and sulfur were disappointing and revealed no justification for artificial soil acidification in the field as a means of control. The culture of eggplant on naturally acid sod land offers the best means of controlling wilt. The investigation is concluded with this report.

Control of Greenhouse Vegetable Diseases. (E. F. Guba, Waltham.)

Tomato leaf-mold. Extensive tests reveal the lack of immunity among any varieties of tomatoes to attack by *Cladosporium fulvum* Cke., but some varieties show a mild resistance as expressed in slight spore production, belated infection, and yellow spots, in contrast to a rich growth of the fungus on foliage of susceptible varieties. The varieties Maincrop, Up-to-Date, Norduke, and Norton were most resistant. Maincrop and Up-to-Date produce small, smooth tomatoes and set heavily; Norduke and Norton produce large, rough tomatoes and set very poorly under glass. Reciprocal crosses of these varieties have been obtained for future study. Riverside X Up-to-Date, Stonnors M. P. X Up-to-Date, Maincrop X Up-to-Date, and E. S. 1 X Up-to-Date, crosses made by Dr. W. F. Bewley of England for resistance to *Cladosporium*, are similar to Maincrop and Up-to-Date in cropping characters and resistance. Of these four hybrids, Stonnors M. P. X Up-to-Date and Maincrop X Up-to-Date were most resistant. These hybrids have been crossed further with Norton and Norduke in the hope of developing a suitable greenhouse tomato which is, at least, less troubled by the disease than the standard varieties now being grown.

A paper dealing with the relation of environment to the development and control of tomato leaf-mold under glass is in preparation.

Effect of hydrocyanic acid gas on cucumber plants sprayed with copper fungicides. Cucumber plants were always injured when gas followed copper fungicides containing calcium hydroxide, sodium hydroxide, or sodium carbonate. Even when the alkali compound was reduced to produce neutral mixtures, injury resulted after gas. Injury occurred regardless of whether the gas was evolved from Cyanogas or from sodium cyanide, or whether chemical hydrated lime, milk of lime, or lime water was used in the preparation of Bordeaux.

Injury was always correlated with water soluble copper which increased with the amount of alkali present in the spray.

Residues of Bordeaux on glass acted upon by gas yielded soluble copper and hydrocyanic acid gas, and these occurred in a fairly constant ratio. The toxic salt is presumably calcium cuprocyanide $\text{CaCu}_2(\text{CN})_4 \cdot 5\text{H}_2\text{O}$.

If spraying greenhouse cucumbers with Bordeaux is warranted, fumigation with hydrocyanic acid gas should precede the copper treatment, or cyanide fumigation should be abandoned in favor of tobacco fumigants. The investigation is concluded with this report.

Control of the root-knot nematode in greenhouses with carbon disulfide emulsion. This investigation has been completed and the results published in Bulletin 292.

Eradication of Nematodes in Greenhouse Soils by the Use of Chemicals. (L. H. Jones.) In further experiments, using a mixture of liquid orthodichlorobenzene adsorbed in diatomaceous earth and calcium cyanide, nematodes were eradicated from soil in six-inch flower pots that was heavily inoculated with large

nematode galls from tomato roots. Orthodichlorobenzene adsorbed by diatomaceous earth and lacking calcium cyanide has little nematocidal value. Calcium cyanide alone will materially reduce the injury caused by nematodes, but the addition of orthodichlorobenzene prolongs the nematocidal activity of the cyanide and has effected eradication.

The most effective mixture from the standpoint of eradication without subsequent injury to seed germination and plant growth proved to be, by weight: 1 part orthodichlorobenzene (12.5 grams) adsorbed by 4 parts diatomaceous earth (50 grams) and then mixed with 2 parts calcium cyanide (Cyanogas) (25 grams). Two treatments of the soil are necessary with this mixture, with an intervening interval of a week, and a final interval of 10 days before seed is planted.

Acetic Acid and Pyroligneous Acid as Soil Disinfectants. (W. L. Doran.) It was found that either of these chemicals can be substituted for formaldehyde for soil disinfection to prevent damping-off, and at less cost than formaldehyde. A description of this work has been published in the *Journal of Agricultural Research* 44:571-578, April 1, 1932, under the title, "Acetic acid and pyroligneous acid in comparison with formaldehyde as soil disinfectants." Undistilled pyroligneous acid was more effective than the distilled.

Germination of onion seeds was not injured by pyroligneous acid 6:100, 65 gallons per acre, applied to soil in the open row at the time of seeding. This treatment did not entirely prevent onion smut, however.

A dust containing 6 per cent glacial acetic acid (in diatomaceous earth), when applied to soil at the rate of 42.5 grams per square foot, afforded less complete protection against damping-off than did acetic acid applied in water to the soil. This dust applied to soil immediately before seeding did not injure the germination of beet and tobacco seeds.

Carnation Blight (*Alternaria dianthi* S. & H.). (E. F. Guba, Waltham.) Production of the best blooms was lowest with December cuttings and highest with March cuttings when benching was done on July 20, and this was influenced by a corresponding difference in the prevalence of both *Alternaria* blight and *Fusarium* wilt. Extensive observations in carnation nurseries in 1931 indicated a correlation between greater prevalence of disease and early propagation. Heavy rains in the summer of 1931 were an important factor influencing the losses from these diseases, but benching in advance of the heavy rains in July contributed greatly to their effective control.

In a test of the control of blight in the field with fungicides, Bordeaux 4:4:50 containing one pound of calcium arsenate and one-half pint of fish oil gave the best control. A spray of nicotine sulfate, salt, and fish oil, which is used occasionally to combat red spider on carnations under glass, was not an effective treatment for blight, and a spray of zinc sulfate, lime, aluminum sulfate, and fish oil, recommended in the Middle West for controlling the bacterial spot of carnations (*Bacterium woodsii* EFS), was of no value.

With the present crop, results have been obtained which show the value of using Bordeaux in the field. Results also show that early housing is of far greater value in the control of blight, and where practiced the use of fungicides in the field would appear not to be warranted.

Strawberry Gold Leaf. (E. F. Guba, Waltham.) This trouble is genetic and non-infectious, subject to modification by the environment. Seedlings of Howard 17 develop the characteristic symptoms of chlorosis. Degeneration of chlorophyll which is associated with this disease accounts for weak growth and often death. Badly chlorotic seedlings succumb soon after the leaves appear.

Adherence to asexual propagation from the original Howard 17 clon is apparently effective in avoiding the disease.

Forcing Gladiolus with the Aid of Artificial Light. (L. H. Jones.) In an effort to determine how many nights gladiolus (Crimson Glow) should receive artificial light (from 500-watt bulbs), a succession of plots was arranged to receive artificial light for one, two, three, and so on up to, and including, fifteen weeks. The check plot received no artificial light. Owing to poor soil, the results were not wholly satisfactory, but the trend of results checked with the results of previous experiments. Flowering spikes occurred when daylight was supplemented with artificial light in growing Crimson Glow planted in early autumn. Practically no flower spikes were developed when no artificial light was supplied. The greater number of flowering spikes was found in the group of plots that received the light for more than six weeks after the first leaf appeared above ground. Some flower spikes were developed in the plots receiving light for three and four weeks, and they bloomed earlier than flowering spikes receiving more light. This early blooming is consistent with previous results which have shown that, although artificial light aids in the development of flowering spikes, it also retards the date of blooming.

Plant Containers. (L. H. Jones.) In a continuation of the investigation of the effect of type of flower pot on plant growth, there has been no indication that the degree of soil acidity was altered in its range of fluctuation by either a non-porous wall or the absence of a drainage hole. Aeration of soils in both porous and non-porous types of flower pots takes place through the surface of the soil. By means of rubber vacuum discs, it was demonstrated that air did not pass through the wall of a moist clay flower pot. Two-thirds of the evaporation of moisture from fallow soils in clay pots on a dry surface took place through the wall of the pot, indicating that there was twice as much movement of water laterally as vertically. When the clay pot was on a moist surface, a considerable proportion of the moisture lost was replaced from the moist surface, and this replacement was inversely proportional to the amount of moisture in the soil of the pot.

Root development in the clay flower pot takes place, for the most part, adjacent to the inside wall of the pot. However, in plant containers of paper, glass, and metal, the root system ramifies through the soil mass with but a very small proportion of the roots occurring next to the wall of the container. The type and amount of root distribution is more closely related to moisture conditions in the soil, and possibly to nutrient relations, than to soil aeration.

Plant containers made of paper resistant to the decomposing action of soil organisms have proved satisfactory for the germination of seeds, production of seedlings, and development of plants. Paper pots made of heavy paper that decomposed, induced a nitrogen deficiency in the soil. However, if the paper was light weight, the pot was practically destroyed before a nitrogen deficiency occurred.

To moisten properly the soil mass in clay pots which became dry, two normal waterings were necessary. For non-porous containers, one normal watering was sufficient to accomplish the same object.

Nutrient Factors in Relation to the Region of Root Distribution in Plant Containers. (H. D. Haskins and L. H. Jones.) Preliminary work has laid the foundation for an investigation concerning the relation of nutrient movement in plant containers to moisture movement as influenced by evaporation forces. Bottom watering was followed by resulting incrustations on the surface

of the soil in the non-porous pots, but not in the porous pots. In the non-porous container, the only place where evaporation can occur is at the soil surface. In the porous pots, there is a greater loss of soil moisture through the wall of the pot than from the soil surface. It thus appears that the soluble salts move in the same direction as the moisture. Chemical analysis showed that, in soils in clay pots, the disappearance of nutrients became successively slower from the region near the pot wall to the center of the soil mass. In a porous or clay pot the most extensive root development takes place near the inner surface of the pot; while in a non-porous pot the root system ramifies throughout the entire soil mass.

Diseases of Outstanding Importance in 1932. (O. C. Boyd and W. H. Davis.)

Cherry bacterial blight (believed to be due to *Bacterium cerasi* F. L. Griffin rather than *B. pruni* EFS.).

Downy mildew (*Pseudoperonospora cubensis* (Berk. and Curt.) Rostew.) of summer squash and Blue Hubbard winter squash.

Anthraxnose of watermelon caused by *Colletotrichum lagenarium* (Pass.) Ell. and Hals.

Twig blight and canker of *Juniperus* sp. caused by *Phomopsis* sp.

Bacterial spot of carnation caused by *Bacterium woodsii* EFS.

Peach scab caused by *Cladosporium carpophilum* Thuem.

Pear scab caused by *Venturia pyrina* Aderh.

Fire blight of pear, apple, and quince caused by *Bacillus amylovorus* (Burr.) Trev., largely confined to yard trees and neglected orchards.

Spur blight of raspberry caused by *Mycosphaerella rubina* (Pk.) Jacz. on Herbert and other red varieties; anthracnose caused by *Plectodiscella veneta* (Speg.) Burk. on both red and black varieties; *Mycosphaerella rubi* E. W. Roark, although not unusually prevalent on foliage, caused severe girdling of bearing canes of red varieties on Cape Cod.

Gray mold rot of strawberry caused by *Botrytis cinerea* Auct.; stunt, barrenness, and early dying of strawberry plants, apparently due to the disease, "dwarf" or "crimps," caused by the nematode, *Pathoaphelenchus fragariae*.

Bacterial wilt of cucurbits caused by *Bacillus tracheiphilus* EFS.

Downy mildew of cucumbers and muskmelons.

Wilt of winter squash caused by *Mycosphaerella citrullina* (C. O. Smith) Gross.

Early blight of celery caused by *Cercospora apii* Fresen.

Bean Blights caused by *Bacterium phaseoli* EFS. and *B. medicaginis phaseolicola*.

Downy mildew of onion (*Peronospora schleideni* Ung.).

Mosaic of tobacco.

Cytospora canker of Blue and Norway spruces, caused by *Cytospora* sp.

Peony blight caused by *Botrytis paeoniae* Oud.

Hollyhock rust (*Puccinia malvacearum* C. G. Bertero).

Delphinium black spot caused by *Bacterium delphini* (EFS.) Bryan.

Tulip blight caused by *Botrytis tulipae* (Lib.) E. F. Hopkins.

Rose black spot caused by *Diplocarpon rosae* Wolf, and powdery mildew, *Sphaerotheca pannosa* (Wallr.) Lév.

Iris rhizome soft-rot caused by *Bacillus carotovorus* L. R. Jones.

Bacterial wilt of sweet corn, caused by *Aplanobacter stewartii* (EFS.) McC.

Smut, *Ustilago zeae* (Beckm.) Ung., caused more loss to corn than all other diseases combined and appeared to be more damaging than in the average season.

Late blight of tomatoes, caused by *Phytophthora infestans* (Mont.) DeBary, which ordinarily causes very slight or no damage in Massachusetts, assumed

epidemic form in September, and destroyed not only the last pickings of the early crops but practically all of the late fields in the eastern half of the State. In addition, it ruined varying portions of the fall crop in many greenhouses in the Boston Market Garden section. The disease did not reach the Connecticut Valley crops until shortly before the fields were abandoned because of freeze injury. The only previously reported occurrence of this disease in Massachusetts was in 1905, when the damage was slight.

THE CRANBERRY STATION

(East Wareham, Massachusetts)

H. J. Franklin in Charge

Injurious and Beneficial Insects Affecting the Cranberry. (H. J. Franklin.)

Control of the cranberry root grub (Amphicoma vulpina). Some of the cranberry growers now have very efficient rigs for treating this pest with cyanide solution. Three-quarters of an acre a day can be treated with one of them at a cost of not over \$55 an acre, with the present wage scale. However, this treatment never kills quite all of the grubs and so probably must be repeated in about ten years. Because of this and the cost of the treatment, it has seemed desirable to develop a control by flooding if possible. In this connection, the season's experience in the flooding of two badly infested bogs seems highly suggestive. On one of these bogs the full winter flood was held till July 4. This very late holding of the winter water failed to reduce the grub infestation noticeably. The winter flood was removed from the other bog on April 3, and the bog was reflooded again from May 16 to July 9, the water ranging from 6 inches to 2 feet deep over the sand surface. The temperature of the water of this reflood was taken in two widely separated locations carefully selected to represent average conditions, at depths of 6 inches and 1 foot, at 7 a. m. and 2 p. m. from May 27 to July 9, inclusive. The following table shows the range of these temperatures.

			Temperatures — °F.			
Months			At one-foot depth		At six-inch depth	
			7 a. m.	2 p. m.	7 a. m.	2 p. m.
May (5 days)	Highest		66	72	67	74
	Lowest		58	67	59	67
	Average		63	69+	62	70
June (30 days)	Highest		73	87	73	88
	Lowest		58	63	58	64
	Average		64+	74+	64+	76
July (9 days)	Highest		72	82	73	84
	Lowest		66	70	65	70
	Average		68+	77	68+	77+

So few of the grubs survived this reflood that they could hardly be found. It seems certain that the grubs were killed by the long reflood following, after a considerable period, early removal of the winter flood; but as the results of this treatment were so markedly different from those obtained by very late holding of the winter water, it should be tried further.

It was observed that the false blossom leafhopper (*Ophiola*) hatched in considerable numbers on both bogs after the late flooding operations described above.

Pyrethrum dust. (Dr. E. A. Richmond, employed locally by the Crop Protection Institute, cooperating.) The last annual report of the Cranberry Station con-

tained a brief statement of the results of tests to control certain cranberry pests with pyrethrum dust mixed with a gypsum diluent of 300-mesh fineness. All that dusting was done with hand dusters.

This year work with this dust was continued, but with a Root power duster mounted on a carriage home-made for use on cranberry bogs. In general the results of this work were highly satisfactory. The rig was drawn around on the bogs by two men, and they evidently injured the vines no more than spraying operations do.

Many tests were conducted in which different quantities of a mixture of the dust, made up of 1 part of pyrethrum and 9 parts of gypsum by weight, were applied in treating the false blossom leafhopper (*Ophiola striatula*). As little as 70 pounds to an acre gave a satisfactory kill in some cases; but because of the variation of pyrethrum in toxicity and of the difficulty of making an entirely even distribution of the dust, it was finally found that 100 pounds was about the right amount to use. Reasonably careful dusting with this amount of the mixture was commonly found to kill 99 per cent of the hoppers present. This treatment was a more effective and generally more satisfactory control for this insect than either spraying or flooding have ever been. It was also cheaper than spraying. Perhaps its most important advantage over flooding and spraying is that it may be applied without any risk when the vines are in full bloom and all the hoppers have hatched.

A dust mixture of 4 parts of pyrethrum and 6 parts of gypsum, by weight, used at the rate of 100 pounds to the acre, proved as effective as a pyrethrum soap spray for the control of the second brood of the black-headed fireworm (*Rhopobota vacciniana*) when the worms were small but rather well sewed up in the cranberry tips. This dust has not been tried against the first brood of this insect.

One part of pyrethrum to nine parts of gypsum, applied with hand dusters, was fairly effective in killing the moths of the cranberry girdler (*Crambus hortuellus*), but it is probable that a 2 to 8 mixture is advisable for this purpose.

Gypsy moth and contact sprays. The gypsy moth was very abundant this year in a large part of the Cape Cod region. As this prevalence came after several years of relative scarcity, it caught a good many of the cranberry growers napping, and bog infestations were rather generally neglected till the worms were considerably grown. This promised to develop into a serious situation, for stomach poisons are not effective on cranberry bogs against the caterpillars of this insect after their early stages, and very many bogs were without water supplies for flooding. Immediate attention was given to work with contact sprays, and it was found that the following sprays killed the worms in all stages satisfactorily when used at the rate of 400 gallons to the acre:

1. Pyrethrum soap.....	7 pounds	2. Nicotine sulfate.....	1½ quarts
Water.....	100 gallons	Soap.....	4 pounds
		Water.....	100 gallons

These sprays were most effective when applied early in the morning, for then the worms usually work in the tops of the vines where they are easily reached with a spray more than they do later in the day.

Nicotine sulfate and the cranberry fruit worm. It has become evident, as a result of spraying carried on in several seasons, that a nicotine sulfate spray at the end of the cranberry blossoming period controls the fruit worm to a considerable extent. As it has not been clear how it does this, special experiments were conducted, and it was found that the insect is affected by the spray in the three following ways:

1. Some of the moths are killed and many more are driven off of the sprayed area.

2. Most of the eggs well hit by a spray of 1 quart of nicotine sulfate in 100 gallons of water fail to hatch. This ovicidal action would be more valuable were it not so difficult to reach a high percentage of the eggs without running up the cost by applying a great amount of the spray.

3. Cranberry vines and berries treated with a spray of 1 1/3 quarts of nicotine sulfate in 100 gallons of water strongly repel the moths from laying their eggs for at least 5 days. This occurred in cages both in the laboratory and on a bog, the moths having been introduced some time after the treatment was applied and living in most cases till well toward the end of the test.

Control of the cranberry spittle insect. The general experience of cranberry growers and the results of the season's study indicate that it requires 1 1/3 quarts of nicotine sulfate and 4 pounds of soap in 100 gallons of water applied at the rate of 400 gallons to the acre to control this pest where water for flooding is not available. Pyrethrum sprays and dust fail to check it properly.

Weather Observations. (H. J. Franklin.) Daily local weather observations were made and reported to the office of the Weather Bureau at Boston. Further records bearing on frost forecasting were made for the station by observers at North Harwich, East Gloucester, Carlisle, Fitchburg, Worcester, and Holliston.

Cranberry Varieties. (H. J. Franklin.) The study of varieties was continued during the early months of 1932. A comparative study of their characters in detail, as related to their places of origin, revealed the fact that the native cranberry floras of New Jersey, the Massachusetts mainland, and outer Cape Cod have had significant separate evolutions.

Bog Irrigation. (H. J. Franklin.) On July 20, 1932, during a drought, a square area of bog surface of 100 square feet was wet with 150 gallons of water (about 65,250 gallons per acre), and on this plot two thermometers were placed a few feet apart with their bulbs at the same height as the cranberry flowers and young fruit (about 4½ inches above the bog surface.) For comparison two other thermometers were similarly placed on the bog about 30 feet outside the watered plot. All the thermometers were occasionally shifted in location to get as accurate averages of the relative temperatures as possible. The results were as follows:

Date	Weather Conditions	Hour	Average Temperature °F.		Difference between watered and unwatered °F.
			Watered plot	Unwatered Check	
July 20	Clear, slight breeze	2 p. m.	98.75	100.25	1.5
July 21	Clear, slight breeze	2 p. m.	97.50	99.75	2.25
July 22	Clear, strong breeze	12:30 p. m.	96.62	100.50	3.88
July 22	Clear, slight breeze	1:30 p. m.	95.87	98.92	3.05
July 23	Cloudy	2 p. m.	76.25	77.	.75

On July 23 a second plot, like the one watered on July 20, was wet with 150 gallons of water, and 25 gallons more were added on July 25 at 7 a. m. Two thermometers were placed on this plot also. The following table records the average temperatures on the two watered plots and the unwatered check.

Date	Weather Conditions	Hour	Average Temperature °F			Average difference between watered and unwatered °F
			Plot watered	Plot Watered	Unwatered check	
			July 20	July 23		
July 25	Clear, strong breeze	2 p. m.	92.25	92.38	96.91	4.59
July 26	Clear, strong breeze	12:30 p. m.	89.25	88.43	92.1	3.26

The general average difference in temperature between the watered and unwatered plots for five days (excluding one cloudy day when practically no difference occurred) was 3.08° F. Readings taken at different times of day indicated, as would be expected, that the greatest difference occurred in the early afternoon, i. e., during the warmest part of the day. It is interesting to note that even six days after water was applied to the first plot, the difference in temperature, in comparison with the unwatered bog, was as great as during the first day after application.

During the period when the berries were setting, considerable injury to the crop occurred on many bogs, for many flowers turned brown and dry and, of course, did not set fruit. Drought conditions caused most bogs to be unusually dry during the blooming season. The critical temperature above which cranberry flowers are injured is not known; but in view of the effect which watering has on the air temperature above and near the surface of a bog, as shown by the experiments just outlined, it seems probable that had the bogs been as moist as in normal seasons, the temperature might in many cases have remained below the point where injury occurs. How much this reduction of temperature is due to transpiration from the cranberry plants and how much to direct evaporation from the bog, it is impossible to say. Both these factors, however, depend more or less on the supply of moisture in the surface soil of the bog.

Cranberry Pollen Studies. (W. H. Sawyer.) Through a detailed study of the cranberry flower and pollination, several interesting facts have been developed.

Even during hot, dry weather, if pollination does not occur, the stigma remains moist and receptive for pollen for seven days, and under more favorable conditions of coolness and moisture, it is evident that pollination can take place for a considerably longer period. This is very significant on its influence in insuring a set. Also pollen must be thoroughly ripe before it is capable of germination, and such pollen is found only in anthers that have begun to shrink and turn brown.

When pollen is ripe it is shed from the anthers upon the slightest disturbance. A little pollen may be shed when the flower first opens, but maximum liberation takes place a few hours before the style has elongated enough to bring the stigma even with the anther tips. This occurs from twenty-four to thirty-six hours after the flower has opened.

The shape of the flower and the arrangement of the stigma and anthers are such as to supply reasonable justification for a lack of self-pollination. Distilled water was found to be as satisfactory as any other medium tried for the germination of cranberry pollen, but the pollen tubes did not grow very satisfactorily after germination. A 1 per cent solution of cane sugar was found to be the best medium for all purposes, and the best results were obtained when the pollen floated on the surface of the solution.

The range of temperature for pollen germination under laboratory conditions was 29°C.; with a minimum of 8°, the optimum from 28° to 32°, and a maximum of 37°. Within the temperature range where germination was possible, the percentage of germination remained constant, but there were variations in the time required, and these differences were also influenced by the variety.

It is evident from yield records of several varieties that there is a correlation between a high percentage of pollen germination and high yield, in spite of the fact that it would seem reasonable to assume that even the varieties with poor-germinating pollen would disseminate sufficient pollen to meet all "set" requirements.

DEPARTMENT OF DAIRY INDUSTRY

J. H. Frandsen in Charge

Frozen Fruits and Their Utilization in Frozen Dairy Products. (M. J. Mack and C. R. Fellers, Horticultural Manufactures.) This cooperative project has been active for three years. A full report of the investigation has been published in Bulletin 287.

The Vitamin C Content of Strawberry Ice Cream Containing "Frozen Pack" Fruit. (C. R. Fellers, Horticultural Manufactures, and M. J. Mack.) This study was planned to determine the Vitamin C potency of fresh strawberries, frozen packed strawberries, and strawberry ice cream. It was conceivable that Vitamin C might be partially destroyed either in the process of freezing, during storage, or in the rigorous beating of ice cream in the ice cream freezer. However, the data collected by feeding tests on guinea pigs indicate no destruction of Vitamin C either in the frozen storage of strawberries or in the preparation and storage of strawberry ice cream containing the frozen pack fruit. Thus strawberry ice cream may be considered a source of Vitamin C.

A Study of Ice Creams High in Fat Content. (M. J. Mack.) More data have been accumulated on this subject during the past year. Ice creams varying in fat content from 20 to 30 per cent are now being made by many New England manufacturers. Such ice creams vary markedly in character from the usual commercial product in which the fat content invariably lies between 10 and 20 per cent.

The most serious problem which is encountered in the making of high-fat ice creams is to control the viscosity of the mix. An excessive viscosity usually results which interferes with certain processes in making the mix, as well as with freezing and packaging of the product. Some sources of fat prove to be much more satisfactory than others in the control of viscosity. The findings thus far would indicate that, in the making of ice creams high in fat content, the percentage of non-fatty ingredients, as well as processing and freezing procedures, must all be altered wherever possible to bring about lower viscosity of the mix.

The Effect of High Initial Aging Temperatures on Certain Physico-Chemical Properties of Gelatin Dispersions. (W. S. Mueller.) The purpose of this investigation was to determine what effects various high initial aging temperatures have, when used for definite periods of time, on the basic viscosity and gel strength of gelatin dispersions. A gelatin-ice cream mixture, pure gelatin-water solution, and other gelatin dispersions such as cane sugar, butter oil, and plasma solids, were used. This study has been completed and a paper prepared for publication.

The following conclusions have been made:

1. When using a gelatin-ice cream mixture —

(1) Initially aging an ice cream mix for 1 to 6 hours at temperature range of 10° to 30° C. (50° to 86° F.), followed by a low aging temperature, increased the basic viscosity and gel strength over those mixes aged at the low temperature, 2.2°C. (36°F.) only.

(2) As the initial aging temperature is raised from 10°C. (50°F.), this increase in basic viscosity and gel strength reaches a maximum at 20°C. (68°F.), then decreases with further increase of the initial aging temperature.

(3) Initially aging an ice cream mix at or near the transition temperature of gelatin, 38.03°C. (100.5° F.), has no marked effect on basic viscosity and gel strength.

(4) Initially aging an ice cream mix at temperatures above the transition point of gelatin decreases the basic viscosity and gel strength when compared to mixes aged at the low temperature 2.2°C. (36°F.) only.

(5) The magnitude of the basic viscosity and gel strength changes increases with an increase in the initial aging temperature period. However, the first two hours produce the greatest change.

2. The effect of high initial aging temperatures on pure gelatin-water solution was similar to that on gelatin incorporated in an ice cream mix.

3. Sugar, plasma solids and butter oil had a marked influence on the magnitude of the basic viscosity increase due to the use of a high initial aging temperature, 20°C. (68°F.).

4. The observed effects of various initial aging temperatures on the basic viscosity and gel strength of gelatin systems indicate that the colloidal behavior of gelatin is affected by factors which are not generally recognized by current theories.

5. The observed increase in basic viscosity and gel strength, due to the use of a high initial aging temperature, points the way to a more economical use of gelatin in ice cream.

The Feasibility of High Aging Temperatures in the Manufacture of Ice Cream. (W. S. Mueller and J. H. Frandsen.) The object of this study was to determine the feasibility of using an aging temperature of 68° F. A four-hour high aging temperature period was selected as standard procedure. The 68° F. aging temperature was used alone and also followed by a low aging temperature. Each mix aged at 68° F. was compared to a portion of the same mix which was aged at 38° F. and served as the control. Comparisons were made on the following factors:

1. Bacterial growth.
2. Titratable acidity.
3. Hydrogen-ion concentration.
4. Basic viscosity.
5. Whipping ability.
6. Body and texture.
7. Melting resistance.
8. Melting appearance.

This study was completed during the past year and is now being prepared for publication.

The following conclusions were drawn:

(1) When an ice cream mix containing gelatin was aged at 68° F. for a period of 4 hours, either alone or followed by a low aging period, the efficiency of the gelatin was increased.

(2) This increased gelatin efficiency was shown by the improvement in body and texture, increase in melting resistance, and slight retardation in rate of whipping when compared to an identical mix aged at 38° F.

(3) When an ice cream mix containing 14 per cent fat, 10 per cent serum solids, 15 per cent sugar, and 0.4 per cent gelatin (175 Bloom) was aged at 68° F. for 4 hours, the efficiency of the gelatin was increased to such an extent that the gelatin content could be reduced 0.1 per cent without any loss in the quality of the finished product.

(4) Aging a pasteurized ice cream mix up to 6 hours at 68° F. had no effect on bacterial growth, pH, and titratable acidity which would be of any commercial significance.

(5) When an ice cream mix containing gelatin was aged at 68°F. for 4 hours, the basic viscosity was slightly decreased, but the basic viscosity was greatly increased when the high temperature aging period was followed by a low temperature aging period, as compared with a mix aged only at 38° F.

(6) When an ice cream mix containing no gelatin or other stabilizer was aged at 68° F. for 4 hours, there was no marked effect on the consistency and whipping ability of the mix or on the melting resistance, body, and texture of the finished product.

(7) When an ice cream mix containing the optimum amount of gelatin for low temperature aging was aged at 68° F. for 4 hours, there was an excessive retardation in melting and a curdled appearance on melting. This objectionable melting behavior can be corrected by a reduction in gelatin without lowering the quality of the finished product.

(8) It is conceivable that in ice cream plants where the cooling of mixes is not being carefully checked, mixes may be aged unintentionally for several hours at a temperature above 50° F. This unintentional high aging temperature in all probability is a big factor in causing the curdled appearance on melting which has troubled some ice cream manufacturers but could not be explained.

The Theoretical Causes of the Factors Involved in the High Initial Aging Temperature Phenomena. (W. S. Mueller.) In order to find an explanation for the structural changes in a gelatin gel, as a result of high aging temperatures, a detailed study of the optical rotation of pure 1 per cent gelatin-water solution was made. Gelatin-water solutions were aged at various temperatures (50°-122° F.) for a period of four hours and then at 36° F. for a period of 44 hours. The control solution was aged at 36° F. only, for a total period of 48 hours. The optical rotation was determined after a total aging period of 24 hours and 48 hours. The results so far obtained show that high initial aging temperatures have no marked effect on the optical rotation after a total aging period of 24 and 48 hours when compared to an identical solution aged at 36° F. only.

The following temperatures were used when studying the changes in optical rotation with time, until optical equilibrium had been obtained: 34.7°, 50°, 68°, 86°, 104°, and 140° F.

The effect of high aging temperatures on the Tyndall phenomenon of pure gelatin-water solutions is now being studied. It is hoped that these data, in conjunction with the optical rotation data, will bring to light a satisfactory explanation for the structural changes in a gelatin gel, due to the use of a high (68° F.) initial aging temperature.

A Study of the Changes that Occur in the Storage of Frozen Sweet Cream. (H. G. Lindquist.) Work has progressed on the preparation of cream for freezing, but no methods thus far have proved satisfactory in studying the changes that occur in the frozen cream.

The Comparative Efficiency of Electrically-operated Tanks versus Ice in the Cooling of Milk. (J. H. Frandsen.) A study of the efficiency of various methods of cooling milk, as practiced under actual farm conditions, is now in progress. The efficiency of most recent electric cooling units is also being studied.

DEPARTMENT OF ENTOMOLOGY

A. I. Bourne in Charge

Investigation of Materials Which Promise Value in Insect Control. (A. I. Bourne.) Weather conditions in the early spring of 1932 were favorable for application of oil sprays. There was very little interruption due to inclement weather. Moderately high temperatures prevailed at the time the buds were breaking, and no sudden drops in temperature were encountered sufficient to cause a breakdown of the sprays and consequent injury to the trees from the free oil liberated. No evidence of burn was noted following any of the oils tested.

Four oil emulsions and two miscible oils were used in the tests against European red mite. At the dilution of 4 gallons per 100, Kleenup gave 95 per cent control; Free Mulsion, 94 per cent; and Emulso, 92 per cent. Used at the rate of 5 gallons per 100, Kleenup showed 98 to 99 per cent control; Free Mulsion, 98 per cent; and Emulso, 95+ per cent. Peninsula Oil Emulsion, a new product on the market, at the strength of 4½ gallons to 100 gave 95 per cent control. The miscible oils, Dendrol and Sunoco, maintained their usual high degree of effectiveness, both showing 98+ per cent control at the standard dilution recommended by their manufacturers.

The present tendency in the use of oil sprays appears to be toward a comparatively few of the standard, well-established types which have been in use long enough to demonstrate their safety and effectiveness under Massachusetts conditions.

Preliminary tests with various insecticides for the control of the Mexican bean beetle indicated that magnesium arsenate, either as a spray or dust, is at present the safest and most dependable material on the market. Both lead arsenate and calcium arsenate caused severe burning, in most cases killing the plants. There is, however, some evidence to show that they might be used, if necessary, during the early season when both temperature and humidity are comparatively low. Barium fluosilicate caused a slight amount of foliage burn during midsummer. However, it showed possibilities for use on late string beans when arsenicals would be objectionable because of residue on the harvested crop. Some of the commercial products containing arsenicals combined with a fungicide proved effective against the insects and safe to the foliage of the beans. They are, however, somewhat expensive, especially if used on large plantings.

In cooperation with the Pomology Department, further studies were made of different "wetttable sulfurs" designed to replace lime-sulfur in the midsummer sprays. The object of these tests was to find a spray that would prove effective against scab and compatible with lead arsenate, and at the same time would avoid the foliage burn and russetting of fruit which almost inevitably follows the use of lead arsenate and lime-sulfur in the post-blossom sprays.

Mulsoid sulfur, Dritomic sulfur and a combination of flotation sulfur and finely divided sulfur were used in combination with lead arsenate. The schedule followed called for a pre-pink, a pink, a calyx, a special curculio and a cover spray and two July applications for railroad worm. The standard lime-sulfur — lead arsenate combination was used on one block, as a basis for comparison. These wetttable

sulfurs were used in all sprays after the special curculio spray. In the sprays up to the calyx spray, lime-sulfur was used as the fungicide.

Tests were continued with Kolofof and flotation sulfur, both of which showed great promise in 1931. Flotation sulfur was available for the first time in a dry powder form. This was much more convenient to handle than the paste form and proved fully as effective. It marked a distinct advance in the manufacture of this product. Kolofof and flotation sulfur (paste and dry) were used throughout the season in one-half of the block in which they were tested. The remainder of the trees received lime-sulfur up to and including the calyx spray and the new materials for the remaining sprays.

While the season was not particularly favorable for spray burn or the development of scab, considerable foliage injury followed the use of lime-sulfur, and unsprayed checks showed sufficient scab to infect nearly 60 per cent of the harvested fruit. No foliage injury or damage to fruit resulted from the use of any of the wettable sulfurs.

The value of these materials in controlling disease and insect pests is shown in the following table, based on examination of the McIntosh crop at harvest.

Treatment	Percentage of Clean Fruit	PERCENTAGE OF FRUIT SHOWING INJURY FROM:		
		Curculio	Codling Moth	Scab
Lime-sulfur.....	85	3	9	1
Lead arsenate.....				
Lime-sulfur.....	95	1	2	0.5
Lead arsenate.....				
Lime.....				
Mulsoid sulfur.....	83	5	4	0.8
Lead arsenate.....				
Flotation sulfur.....	91	2	5	1
300-mesh sulfur.....				
Lead arsenate.....				
Dritomic sulfur.....	92	2	4	1
Lead arsenate.....				
Flotation sulfur (dry)..... (entire season)	86	1+	3	6
Flotation sulfur (dry) after.....	96	0	2	1+
Lime-sulfur.....				
Flotation sulfur (paste)..... (entire season)	80	0.2	2	18
Flotation sulfur (paste) after.....	93	0.3	1	5
Lime-sulfur.....				
Kolofof (entire season).....	89	0.5	3	6
Kolofof after.....	94	0.2	1-	4
Lime-sulfur.....				
Check.....	23	27	19	58

In these tests the lime-sulfur—lead arsenate combination gave equally good control of scab when hydrated lime was added, and the lime reduced the amount

of spray injury to fruit and foliage. Combined sprays of lead arsenate with Mulsoid sulfur, with Dritomic sulfur, and with the combination of flotation and finely-divided sulfurs held scab to 1 per cent injury or less and also controlled insect pests very satisfactorily.

The dry form of flotation sulfur proved as effective against scab as the paste and required much less time in the preparation of the spray. Kolofog again gave very satisfactory control of scab. Samples of fruit sprayed with these materials showed excellent quality and finish. The use of lime-sulfur as a fungicide in the early sprays followed by Kolofog or flotation sulfur in the midsummer applications gave a higher control of scab than that secured by a complete season's schedule of either of these materials. Spray injury was also avoided, and such a program would allow a material reduction in cost to the grower.

Control of Onion Thrips (A. I. Bourne.) Warm weather and a slight deficiency in rainfall during the early growing season offered favorable conditions for the development of thrips, and the very general practice of planting sets close to seed onions practically insured an early and heavy infestation on seed onions. By late June the number of thrips on seed onions was unusually high and some evidence of injury was appearing. Weather conditions during July sufficiently arrested the development of the infestation so that no serious damage resulted except in some fields adjoining set onions.

The insect was somewhat slower than usual in its seasonal development and reached the peak of abundance about a week later than normal. During early August there was a sharp drop in numbers of thrips per plant, from an average of 75 per plant on August 1 to less than 10 per plant on the 15th, and a gradual decrease until harvest.

It was discovered that this sharp decline in abundance of thrips was coincident with the appearance and spread of a parasitic fungus attacking the insects and the presence of an unusually large number of predacious insects. Examination of onion fields throughout the Connecticut Valley region showed that the fungus was generally present and that its development coincided with a rapid decrease in numbers of thrips. It could not be definitely proved that the presence of large numbers of predacious lady beetles was associated with the spread of this fungus. Coccinellids have, however, been reported to feed on spores of certain of the lower Cryptogams and their presence in abnormal numbers very generally throughout onion fields in the Valley offers a possible explanation of the general distribution and rapid spread of the fungus.

Throughout the growing season observations were made of different strains of onions, in connection with the work of the Agronomy Department on onion varieties, and a marked difference in reaction of various strains to thrips attack was noted. While no strain was found to be immune, certain types were scarcely affected by the feeding of thrips, which caused other types to curl badly and practically terminated their growth.

Comparative tests of nicotine sulfate, Derrisol, and a compound of rotenone in dust form indicated that nicotine sulfate sprays gave the greatest reduction in number of thrips, and their action was more rapid than that of other products. The derris compound was somewhat slower in its initial action than nicotine but appeared to exert considerable residual effect, which retarded reinfestation except that caused by migration of thrips from adjoining fields. The rotenone compound proved least effective of the materials tested, probably due to the fact it was in the form of dust which, with present machinery for application, does not penetrate the tight axils of the leaves as satisfactorily as a spray.

The Spray Residue Problem. (A. I. Bourne.) The dry weather that prevailed during the past summer again forced the problem of spray residue upon the attention of the fruit growers. The rainfall during June was nearly 1 inch less than the normal, and more than half of the precipitation for the month occurred in one storm. There was a deficiency of half an inch in July and of more than 1½ inches in August. While the rainfall in September was slightly greater than the normal, almost 60 per cent of this amount occurred in two storms late in the month when the McIntosh crop had been harvested. During October there was slightly more rain than normal. The fact that the greater part of the deficiency in rainfall occurred during the spraying season and extended up to time of harvest made the problem acute for early varieties and McIntosh. The precipitation in late September and October very largely removed the danger in the case of late varieties such as Baldwin. This deficiency in rainfall in itself was sufficient to make readjustment of the spray schedules necessary, but its effects were reflected also in the seasonal development of several important pests, notably railroad worm, which made proper timing of late sprays very difficult.

In many cases growers failed to apply the late sprays necessary for maggot control. Others made these applications only on late varieties. In both cases failure to control maggot resulted.

Growers who sprayed in late July or early August encountered the problem of residue on McIntosh in excess of the tolerance or dangerously near it. Growers who dusted in late summer again proved that this offers one of the most satisfactory solutions of the problem under Massachusetts conditions at present.

In preliminary tests a non-arsenical stomach poison showed to good advantage as compared with lead arsenate. This indicates a possible way out of the difficulty without forcing the growers to the practice of washing their fruit.

Systematic Study of Oil Sprays. (A. I. Bourne in cooperation with the Department of Chemistry.) The five samples tested this season were all prepared with the same emulsifying agents. The oils ranged from a spindle oil to a medium turbine oil and varied in their viscosity from 203 seconds to 619 seconds at 70° F. One sample was an asphalt base oil; the others were of the paraffin base type. These were applied as delayed dormant sprays in the college orchard, to test their comparative efficiency against overwintering eggs of European red mite and their toxicity to the trees. All the samples went into the spray solution without difficulty. They showed no tendency to break, even when dissolved in very cold water. Their efficiency as insecticides is noted in the following table.

Sample	Percentage of clusters free from mites	Number of mites per 100 leaf clusters
A3	55	70
B3	65	100
C3	60	87
D3	66	67
E3	66	73

All the samples gave practically perfect control. The differences above are too small to be of significance when compared with unsprayed trees which showed an infestation of more than 500 mites on single clusters and averaged more than 18,000 mites per 100 clusters. No injury to buds by burning of tissues or retarding of growth was noted.

Apple Maggot Control. (A. I. Bourne.) Apple maggot was more abundant throughout the entire State this past season and caused more damage than

has been reported in any year of its present period of abundance. The peak of emergence of flies was later than normal, and the flies were active in the orchards over a much longer period than usual. This was largely associated with the very light rainfall during late spring and early summer which left the soil dried and hard packed, a condition very unfavorable for the emergence of the flies. Under such circumstances proper timing of the sprays was difficult.

In the demonstration orchards where the growers were devoting especial attention to maggot control and carried out a complete control program, the pest was held to an average of less than 1 per cent damage. In the 14 blocks from which records were taken, 4 showed no fruit injured by maggot, and in 4 others the number of injured apples was 3 or less. In 7 of the blocks the fruit scored 85 per cent clean or higher, and in every case maggot injury was held to a lower figure than that of any other major pest.

One of the outstanding features of the season's work was the influence of orchard environment or, in other words, the necessity of proper treatment of neglected trees or orchards surrounding commercial blocks. Many growers found that even with the most thorough program possible they could not control maggot in their orchards because of the exposure of their blocks, on one side or more, to neglected apple trees.

The experience of the past season demonstrated that growers in whose orchards apple maggot is a problem must take suitable precautions to clean up their orchard surroundings, since the influence of orchard environment is in most cases the limiting factor determining satisfactory control of the insect or complete failure.

Introduction of Parasites of Oriental Fruit Moth. (A. I. Bourne.) During the last two years the Department of Entomology has cooperated with the U. S. Bureau of Entomology in the introduction and establishment of parasites of the Oriental fruit moth. Colonies of *Macrocentrus ancylovorus* were liberated in peach orchards throughout Hampden County where the infestation of fruit moth was sufficient to allow the establishment of the parasites.

Recoveries from twig collections indicated that the parasites were able to survive the winter of 1931-32 in Hampden County and build up a considerable population in the peach orchards the following spring. In orchards where liberations were made in 1931, a considerable reduction was noted in early twig injury the following spring, and growers reported beneficial results on the basis of the crop at harvest.

If a sufficient supply of parasites can be obtained, more extensive liberations will be made another season in other peach-growing sections of the State into which the fruit moth has now spread.

Plum Curculio. (W. D. Whitcomb.) Studies of the plum curculio under controlled temperatures maintained at 55°, 65°, 75°, and 85° F. were continued with special attention to influence of temperature on oviposition. The activity of ten pairs of mated beetles at each temperature was recorded daily.

The number of eggs laid increased at each higher temperature in an approximate ratio of 1:5:9:12, and about 75 per cent of the eggs were laid during the first 20 days of oviposition regardless of the temperature. Slightly more eggs were laid in the first 10 days than later, but the ratio of egg punctures to feeding punctures was about 4 per cent greater in the second 10-day period. At each temperature the last eggs were laid about 55 days after oviposition began. The average number of eggs per female per day laid during the first 20 days was 0.72 at 55°, 3.44 at 65°, and 10.21 at 85° F. The maximum number of eggs laid during life by one female

beetle was 41 at 55°, 169 at 65°, 240 at 75°, and 332 at 85° F., while the greatest oviposition in one day was 22 at 85° F.

Development of the immature stages was not completed at 55° and was very slow at 65° F. At 75° all development increased rapidly, and a slight additional stimulation occurred at 85° F.

When the beetles had only poisoned apples for food, the average number of days which they lived decreased with each increase in temperature and with each increase in concentration of lead arsenate from 3 pounds in 100 gallons to 4, to 5, to 6 pounds. The number of days in which the poison killed the beetles was quite consistent at the two higher temperatures, but at 55° and 65° F. the time was much more variable among individuals. The activity of the beetles was inconsistent when feeding on fruit sprayed with the lowest concentration of lead arsenate, but at the higher concentrations the average number of punctures per beetle before death decreased from 4.5 on 4 pounds to 3.3 on 5 pounds to 2.3 on 6 pounds of lead arsenate per 100 gallons of water with no consistent variation in respect to temperature. With one exception the average number of eggs per beetle was less than two in all fruit sprayed with lead arsenate at the rate of 4 pounds or more per 100 gallons. In the majority of the experiments no eggs were laid in sprayed fruit more than two days after the first activity took place.

The comparative effectiveness of spray and dust for the control of the plum curculio in apples was studied on Gravenstein at Westford. Applications were made by the grower at the recommended time. Examination of 43,568 apples showed 6.45 per cent of the dusted apples with curculio punctures and 2.80 per cent of the sprayed apples. A similar percentage in favor of the spray treatment was apparent in both the dropped fruit and harvested fruit.

Naphthalene as a Fumigant for the Control of Greenhouse Insect Pests. (W. D. Whitcomb.) Experimental fumigations with vaporized naphthalene in a tight chamber at the rate of 1½ ounces in 1,000 cubic feet resulted in practically perfect control of red spider nymphs and adults from one fumigation of six hours at 80° F. with relative humidities of 90, 80, 70, and 60 per cent. Two and three fumigations at 75° F. gave perfect control at each relative humidity. However, one fumigation at this temperature gave perfect control only at 90 per cent humidity, and the mortality decreased with each decrease in relative humidity from 80 to 60 per cent.

When the dosage was diminished to 1 ounce in 1,000 cubic feet the control was consistently satisfactory only after three fumigations, especially at 60 per cent relative humidity. The natural mortality of the red spider on these plants averaged 13.5 per cent.

The mortality of red spiders when exposed without naphthalene for six hours to the humidities used in fumigating increased with each increase in relative humidity and with each additional exposure. Two exposures of six hours at 80° F. and 90 per cent relative humidity killed over 50 per cent of the red spiders without naphthalene.

Biology and Control of the Carrot Rust Fly. (W. D. Whitcomb.) The potential infestation by the carrot rust fly in 1932 was 8.07 pupae per square foot where carrots were left in the ground over winter and was almost identical with a similar count (8.16) in 1931. However, the abnormally dry weather during June and July practically eliminated economic injury and prevented the building up of a normal second generation infestation. This condition was at least partially explained when none of the eggs confined at a constant temperature of 85° F. hatched while 85 to 90 per cent of them hatched between 55° and 75° F. No

flies emerged from overwintered pupae confined at 85° and only 44 per cent emerged at 75° F. The average date of emergence was 15 days later at 55° than at 75° F. Adults lived longest at 55°, and the largest number of eggs was laid at 75°, but 65° appeared to be the most favorable temperature for normal development.

In the field plantings there was no first generation injury in the untreated check and only one in 2050 carrots examined showed severe injury. The normal field infestation by the second generation was about 10 per cent most of which was slight and moderate, rather than severe. Celeriac was free from injury in comparison to other years when this plant suffered moderate to severe damage. Among new varieties of carrots which were observed for susceptibility, Table Gem and Tendersweet showed a tendency toward injury in spite of the light infestation. Under the existing conditions, broadcasted applications of tobacco dust and soot were very satisfactory when applied three times at weekly intervals, although the plots receiving two applications of these materials showed about the same infestation as the untreated check.

Influence of Temperature on Development of Red Spider. (W. D. Whitcomb.) The abundance of the red spider on greenhouse plants increased with the temperature, and on cool-growing plants such as carnation, injury by this pest can be reduced to a minimum by maintaining temperatures near 50° F. during cool weather. In experiments at 50° F. development of the younger stages was not complete, although some eggs were exposed for 57 days before it was determined that they would not hatch. The average number of days required for development from the newly laid egg to the adult was 29.1 at 60°, 12.4 at 70°, and 7.0 at 80° F. Eggs were hatched in 11.72, 5.35, and 3.53 days at the higher temperatures respectively, and over 90 per cent of the eggs hatched at these temperatures.

Although red spider eggs do not hatch at 50° F., there is a slight biologic development at this temperature which causes hatching in less than the normal period when the eggs are transferred to more favorable temperature. This biologic development varies directly with the length of exposure at 50° F.

DEPARTMENT OF FARM MANAGEMENT

J. A. Foord in Charge

Enterprise Relationships and Farm Organization on Selected Dairy Farms in Massachusetts. (R. L. Mighell.) Studies of the effect of replanning the labor program and the internal organization of enterprises on dairy farms have been continued. It has been discovered that significant savings in labor can be made in many farm tasks, for example daily chores, by means of careful planning. Frequently an inexpensive piece of equipment, or slight change in routine, will result in a considerable reduction of labor time. For example, on one farm the installation of an 18-foot extension of pipe line made a net saving in chore time of 13.4 minutes daily or more than 1½ hours per week.

Types of Farming in Vegetable Garden Areas. (R. L. Mighell, J. E. Thigpen. Cooperative with the Extension Service.) Records secured in the 1930 season have been further analyzed, and the amounts and distribution of labor used on different vegetable crops presented in tabular and graphic form for use in giving a more accurate picture of the types of farming in vegetable areas and in planning more profitable crop combinations. Variations in amounts of labor used for the same operations have furnished the starting point for the study of labor-saving methods and technique.

The Cost of Silage Production in Massachusetts with Special Reference to the Use of Machinery. (C. I. Gunness, J. A. Foord, and J. E. Thigpen. Cooperative with the Bureau of Agricultural Engineering, U.S.D.A., and the Departments of Farm Management and Agricultural Engineering of the Experiment Station.) The analysis of the data from a field study of silage-production methods made in October and November, 1931, shows definite relationship between man-labor inputs and acreage of silage corn, stoniness of the soil, and types of machinery used. The difference in amounts of labor required with and without certain machines can be used as measures of probable labor savings, assuming that other causes of variation in labor are averaged out.

Other basic data resulting from the study are farmers' estimates of annual repairs and probable life of different machines. These data are used in estimating average annual costs of such machinery. The annual costs can then be balanced against the estimated value of labor savings in case the purchase of a new machine is under consideration.

Economical Silage Production on Dairy Farms -- Labor and Machinery Costs. (R. L. Mighell and R. H. Barrett.) This study developed from the preceding one, as one of the most practical and at the same time most inexpensive pieces of labor-saving equipment in silo filling was found to be the low-rack wagon. Only four farms among the 64 studied used such wagons, but their average time for filling silo was only 1.6 hours per ton as contrasted with an average of 2.0 hours per ton for all the farms.

To test these results experimentally, an inexpensive low-rack wagon was built in the college engineering shop in September 1932, with a discarded automobile rear end for the rear wheels and axle and front running gear from an ordinary farm wagon. This wagon was tested under actual silo-filling conditions on the college farm and on four farms near Amherst. On three farms complete time records were taken on all operations. As a typical instance the time required to load silage corn on the low wagon was 23.6 man minutes per ton in comparison with 35.1 man minutes per ton with a wagon 41 inches high. (Average of 16 loads apiece). The low wagon is 22 inches high as compared with 38 inches to 50 inches for wagons in common use. With a low wagon, the corn can all be loaded from the ground without the necessity for anyone on the load. Recent studies in New Hampshire and Connecticut on this type of wagon are in line with these results.

Labor-Saving Methods and Technique on Vegetable Farms. (R. L. Mighell, R. H. Barrett.) This study is one of the first attempts to apply time and motion study methods to the operations on vegetable farms. Analyses of the motion pictures and time records secured in the 1931 season were continued this year, and further field study was directed particularly to asparagus, beets and carrots. As a result of the study of harvesting and packing operations on bunch beets and carrots a new and improved technique has been developed for these tasks. Typical tests of the new method of bunching and tying show that the time has been reduced from 5.3 man minutes per box with a common method now in use to 2.9 minutes per box with the new method.

With asparagus a new system of sorting and packing is being developed from ideas originally thought out by one grower. Preliminary tests indicate that the new system as adapted to fit different conditions will effect a reduction of one-fourth to one-third in the man labor needed on this job. Many minor changes such as rearranging labor crews, subdividing the work differently, providing convenient sorting tables and more desirable field boxes and so on, have been suggested

to growers in the field and tested out with success. Motion pictures have been very helpful in studying detailed operations in certain tasks and also furnish an effective means of presenting results to growers.

Live Stock Management, Methods and Costs. (J. A. Foord.) The positive reactors to the blood test for Bangs disease from the college herd have been kept in loose pens for three years, being "tied up" only for milking and grain feeding. The method has shown advantages in reduced hours of labor and amount of equipment needed, although with somewhat higher costs for bedding. Production has been well maintained, and clean milk of low bacterial count produced. Very little more floor space is needed than in the better type of stable. The method is worthy of consideration by practical dairymen.

FEED CONTROL SERVICE

Philip H. Smith in Charge

The Feed Control Service comprises not only feed inspection, but several other activities, as listed below:

Feed Control (General Laws, 1920, Chapter 94)

Seed Control (General Laws, 1927, Chapter 94)

Dairy Law (General Laws, 1920, Chapter 94)

Advanced Registry Testing

Miscellaneous Work

Feed Control. (P. H. Smith, A. F. Spelman, G. J. Larsinos, J. W. Kuzmeski, F. A. McLaughlin, J. T. Howard.) During the fiscal year, 1,607 samples of feeding stuffs were officially collected and examined in the control laboratories. The results show that at least 97 per cent of the samples collected varied less than 1 per cent from stated guarantees in protein, fat and fiber content. The gross receipts from the registration of feeding stuffs in 1932 (calendar year) were \$21,200, derived from 1,060 brands at \$20 each.

Seed Control. (P. H. Smith, F. A. McLaughlin, Margaret E. Nagle.) From October 1, 1931, to October 1, 1932, the seed laboratory analyzed 1516 seed samples, 463 of which were collected by the State Department of Agriculture, 304 sent in by dealers and farmers and 194 by the Rhode Island Department of Agriculture, 354 purchased from wholesalers for special tests. The remaining 201 were accounted for in tests of ingredients of grass seed mixtures, some mixtures containing as many as eight ingredients.

	Massachusetts Official	Massachusetts Non-official	Rhode Island	Total
Purity only.....	41	26	53	120
Artificial germinations.....	257	572	3	832
Field germinations.....	0	(239*)	0	...
Purity and Germination.....	366	60	138	564
	664	658	194	1516
Field crops.....	32	61	18	111
Forage crops.....	375	140	173	688
Vegetables.....	257	446	3	706
Flower seeds.....	0	2	0	2
Tree seeds.....	0	9	0	9
	664	658	194	1516

*239 field tests are duplications of laboratory tests; portions of same samples used.

Field tests to determine trueness to type were again conducted in cooperation with the Department of Agronomy which tested 11 samples of alfalfa, 23 samples of red clover, and 3 samples of sweet clover; and the Department of Olericulture which tested 239 samples of sweet corn and 115 samples of peas.

Dairy Law. (P. H. Smith, J. T. Howard, J. A. Martell, H. L. Allen.) During the year ending December 1, 1932, 7,603 pieces of Babcock glassware were tested. Condemned glassware consisted of four milk-test bottles. One hundred and six certificates of proficiency were awarded.

One hundred and ninety-one creameries, milk depots and milk inspectors' laboratories were visited in order to check methods and pass upon equipment in use. As a result of this inspection, one machine was condemned, and repairs were ordered on twenty-five. Six plants were re-inspected to approve repairs. Special investigations were made at twelve plants.

Advanced Registry Testing. (P. H. Smith.) Advanced registry testing has been supervised by this department since its beginning in 1902. There are now on yearly test 483 cows located on 61 different farms. This does not include the herd tests where all animals in each herd are placed on test. Of these there are fourteen, five of which are supervised by men sent out from this office and nine by cow-test association supervisors.

Miscellaneous Work. (P. H. Smith, A. F. Spelman, J. W. Kuzmeski.) Numerous analyses have been made for residents of the State and other departments of the college.

Summary of Miscellaneous Work, 1932

Materials sent in:

Milk and cream, butterfat only.....	362
Milk, solids and fat.....	29
Feeds.....	108

For other departments of Experiment Station and College:

Milk, for butterfat.....	237
Milk, for solids.....	7
Dry matter, forage crops.	3,196
Complete fodder analyses.....	169
Dry matter and nitrogen.....	116

FERTILIZER CONTROL SERVICE

H. D. Haskins in Charge

Fertilizer Inspection. (H. D. Haskins, H. R. DeRose, A. F. Spelman, J. W. Kuzmeski.) Records for the year show that 106 firms have registered for sale in the State 537 brands of mixed fertilizer and fertilizing materials and 36 brands of agricultural lime and gypsum. The following summary shows the character of these substances, as well as statistics with reference to their inspection.

During ten weeks following April 1, four men employed to draw samples for inspection purposes sampled 23,827 sacks or containers, representing 8,136 tons of material; 848 agents were visited.

Products	Brands Registered	Brands Collected	Samples Collected	Number of Analyses	Number of Determinations*
Mixed fertilizers.....	333	322	1,128	480	5,760
Ground bone, tankage and fish.....	58	55	183	68	325
Nitrogen products, organic and mineral.....	56	50	307	195	396
Phosphoric acid products....	28	26	111	29	116
Potash products.....	18	17	72	28	96
Dried, pulverized natural manures.....	23	22	101	23	115
Nitrate of potash.....	6	6	10	7	28
Miscellaneous.....	15	14	24	16	102
Lime products.....	36	34	72	39	334
Totals.....	573	546	2,008	885	7,272

*Not counting check tests or repeats.

During the period July 1, 1931, to July 1, 1932, the tonnage of fertilizer and plant food sold in Massachusetts was as follows:

	Fertilizer (Tons)	Plant Food Elements (Tons)		
		Nitrogen	Available Phosphoric Acid	Potash
Mixed fertilizers.....	39,689	1,957	3,386	2,725
Unmixed fertilizer chemicals and materials.....	20,325	1,350	1,476	534
Pulverized natural manures.....	1,939	40	27	53
Totals.....	61,953	3,347	4,889	3,312

Full details of the fertilizer and lime inspection will be found in Bulletins 65 and 66, Control Series.

Miscellaneous Analytical Work. (H. D. Haskins, H. R. DeRose, A. F. Spelman, J. W. Kuzmeski.) Cooperative chemical investigations have been carried on, as usual, with other departments of the Experiment Station, as well as with the Waltham Field Station and with County Agents. The character and extent of this work is shown from the following summary:

Celery leaves for mineral poisons.....	1
Complete fertilizers.....	1
Corn stover, ash analysis.....	33
Farm manure.....	1
Fertilizer chemicals and unmixed fertilizer materials.....	23
Hay, for partial ash analysis.....	59
Miscellaneous crops and crop residues for ash analysis.....	6
Oil emulsion.....	1
Soils, analysis of water extract of.....	15
Tomato pulp, dried, complete analysis.....	2

The usual variety of chemical work has been performed for farm organizations and state institutions, as well as individuals interested in agriculture. Reports of results have in all cases been accompanied by interpretations and advice with reference to the problems involved. This group includes the following materials:

Agricultural lime products.....	14
Ashes, cotton hull and wood.....	15
Complete fertilizers.....	20
Fertilizer chemicals and unmixed fertilizing materials.....	22
Insecticides and fungicides.....	3
Manures.....	8
Manufacturers' by-products.....	7
Miscellaneous.....	11
Peat products.....	19
Soils.....	37

Contact and cooperation with the Association of Official Agricultural Chemists has been maintained as in the past, in so far as rulings of the State Administration and the resources of the Control Department would permit.

Vegetation Pot Experiment with Phosphates. Season of 1932. (H. D. Haskins.) This experiment, comprising 101 pots in a study of the phosphoric acid availability of 20 different sources of phosphoric acid, has not reached the stage where positive conclusions are possible.

DEPARTMENT OF FLORICULTURE

Clark L. Thayer in Charge

Study of the Effect of Plant Nutrients on Carnations and Roses Under Glass. (Harold E. White, Waltham.) Urea, Calurea, Cal-Nitro, and ammonium sulfate, when used as the source of nitrogen on a 4-12-4 basis, produced an average of 30 flowers per square foot of bench area, whereas sodium nitrate and calcium nitrate produced 25 flowers per square foot.

Where Calurea was used as a source of nitrogen in a 4-12-4 mixture, applied at the rate of from 1 ton to 4 1/2 tons per acre, there was a decrease of split flowers from 33 per cent to 5 per cent. This would tend to indicate that one means of lessening the tendency of carnations to split is by increasing the rate of application of fertilizers within certain limits. The production of carnation plants was increased from 18 flowers to 31 per square foot by increasing the rate of application of 4-12-4 from 1 ton to 4 1/2 tons per acre. Fertilizer applied at a higher rate than this resulted in a decrease in production. Carnations apparently will stand high application of fertilizers as long as the phosphorus and potash balance is maintained. Plots receiving as high as 10 tons per acre of a 4-12-4 showed no injury other than a reduction in production of flowers. The only exception was in the case of sodium nitrate where applications above 1500 pounds per acre resulted in a stunting of the plants, a reduction in the size of the flowers, and an adhesion of the flower petals. The adhesion symptoms did not occur in any other plots even though the rates of application were the same as for sodium nitrate; neither did dwarfing of the plants appear where the other materials were used in equivalent amounts. The soil reaction does not appear to be a factor where adhesion results from the excessive application of sodium nitrate, since in no case did the pH go above 7.0. The lowest pH, even where high applications of ammonium sulfate were made, did not go below pH 5.0. There was no noticeable effect of source of nitrogen or rate of fertilizer application on the rooting of carnation cuttings. Stem rot was present early in the season in the plots, but there appeared to be no correlation between feeding and severity of this disease on carnations.

Roses seem to give a better yield and make more vigorous growth where organic materials are used than when fed with straight commercial fertilizers. High application of chemical fertilizer reduces production and vigor of the plants.

Breeding Snapdragons for Varietal Improvement and Disease Resistance. (Harold E. White, Waltham.) In the F_1 generation there was no consistent segregation for rust resistance sufficient for definite determination of the resistance factor. For most of the inbred lines studied, resistance to susceptibility approached a 1:1 ratio. With the F_2 generation resistance increased and, while the percentage varied, there was an approximate ratio of three resistant to one susceptible for total resistance. Resistance was so variable that color could not be correlated with resistance. Commercial strains which have been used for breeding have continued to show complete susceptibility to rust. Crossing commercial strains, while resulting in increased vigor, did not make the progeny less susceptible. Resistant strains crossed with pink varieties have resulted in complete susceptibility, even in the F_2 generation.

Double-crossed progeny in the F_1 generation did not show noticeably increased resistance to rust over the single-crossed progeny. The ratio of resistant to susceptible plants in the F_1 generation in both crosses was about the same. Susceptible strains in the F_2 generation gave all susceptible progeny. Susceptible plants from the F_1 generation continued to breed true for susceptibility in the F_2 generation. Between eight and ten thousand plants were grown in the F_2 generation test; selections from these strains are being carried on for the F_3 generation.

DEPARTMENT OF HOME ECONOMICS

Bernice Wait in Charge

The Comparative Value of Milk and Tomato for Supplementary Feeding in Elementary Schools. (B. Wait and M. V. Cowing.) For the past three years the children in a small consolidated rural school have been given a supplementary mid-morning feeding at first of either milk or tomato and later of a combination of evaporated milk and tomato juice. The study is being continued for a fourth year by feeding the children of a control school to ascertain whether any results of the feeding which seemed apparent can be duplicated in this latter group. Whether the data obtained will confirm the observation that there was some improvement in the general well-being of the children as a result of the feeding of either the tomato or the milk or of both, or whether the apparent improvement was sufficient to be measured by the tests applied can not be stated until the analysis of these data has been more nearly completed.

The Value of Evaporated Milk for School Food Service. (B. Wait and O. A. Merriam.) This project is similar in purpose and in method to the above. Throughout two school years the children of the first four grades of the school in a small mill village have been given a mid-morning feeding of eight ounces of re-constituted evaporated milk daily. The general condition of these children at the beginning and the end of the school year as indicated by medical and dental examinations, and their growth, school progress, school attendance, and incidence of colds during the school year have been observed. These same observations have also been made of a control group of children of the same grades in a school in a neighboring village. As in the project above, the control group is being fed this year to ascertain whether any improvement observed in the general well-being of the children of the experimental group can be obtained as well in the children of the control school.

DEPARTMENT OF HORTICULTURAL MANUFACTURES

W. W. Chenoweth in Charge

Technological Investigation and Nutritive Value of New England Fruit Products. (C. R. Fellers and J. A. Clague.) Apple juice extracted within a few seconds by means of a small centrifugal extractor proved to be a very satisfactory beverage, though differing materially in color, flavor, and consistency from pressed sweet cider. The fresh juice darkened rapidly and formed a fine sediment. Both freshly made and 24-hour-old juices had lost 10 to 30 per cent of the vitamin C content of the original fruit. Pasteurized cider and strained apple sauce retained practically no vitamin C, while benzoated cider and unstrained apple sauce retained 20 to 40 per cent of the vitamin C. In the Baldwin apple, the vitamin C is concentrated in the epidermis and in the fleshy cortex. The epidermis is about 4 times as active as the flesh near it, and 6 to 10 times as active as the flesh in the pulp area near the core.

While the Baldwin apple is a rich source of vitamin C, the McIntosh is very poor. When 25 grams a day were fed to guinea pigs, there was some scurvy protection and bare maintenance of weight.

Baldwin apples had lost about 20 per cent of their vitamin C content after 4 to 6 months storage at 36° F.; after 8 to 10 months the loss had reached nearly 40 per cent.

Ten leading New England varieties are now being tested for vitamin C.

Manufacture, Preservation and Nutritive Value of Cranberry Products. (C. R. Fellers and J. A. Clague.) Approximately 50 varieties of cranberries were again examined chemically and made into strained and whole-fruit sauce. Many varieties were found unsuitable for manufacturing purposes. In fact, a blend of several varieties gives the best cranberry sauce in point of flavor. Data were collected on the manufacturing methods employed by canners and preservers of cranberry products. For canning cranberry sauce only well-tinned re-enameled cans will satisfactorily preserve the flavor and color for a year at room temperatures. Corrosion and perforation of the can, and discoloration of the sauce are greatly reduced at storage temperatures of 32° to 40° F. Either slow or quick-frozen cranberries can be used for sauce manufacture. The canned sauce made from frozen berries kept in storage for one year was fully equal in quality to that made from fresh fruit.

Vitamin studies made by P. D. Isham, aided by funds furnished by the American Cranberry Exchange, have further proved the high antiscorbutic value of the fresh and frozen cranberry and whole-fruit cranberry sauce. Strained sauce, pasteurized juice, jelly, and evaporated whole cranberries retained very little vitamin C. Cranberries were shown to contain about 0.2 rat unit per gram of vitamin A. Negative results were obtained for vitamins B, D, and G.

Additional blood and urine examinations were made on young men fed measured quantities of cranberries. The blood alkali reserve was not significantly decreased unless 5 ounces or more of cranberry sauce was eaten. The conjugation of benzoic and quinic acids in the body produced urinary acidities in proportion to the amounts of cranberry ingested, though 5 ounces or less of cranberry sauce produced relatively slight increases in either the H-ion concentration or the hippuric acid. These results indicate that moderate or even generous servings of cranberries may be eaten without fear of reducing the blood alkali reserve to a dangerous degree.

Cranberry juice has been prepared both by the cold-pressing and heat-extraction methods. For cold-pressing, the berries should be ground and allowed to stand in a cool place for 12 to 24 hours to increase the color of the pressed juice.

The yield is about 3.5 gallons of pure juice to 50 pounds of fruit. The clarified diluted juice with the addition of sugar makes a very satisfying beverage and one not at present marketed. The heat-extracted juice is already being manufactured on a commercial basis in this State.

Cranberry jelly has never been a satisfactory commercial product. The jelly is soft and watery. This objection has been entirely overcome by treating the cold-pressed or heat-extracted juices with pectinase enzyme to remove the quick-setting cranberry pectin. This is followed by filtration and the addition of citrus or apple pectin. A perfect jelly retaining all the flavor and color of the cranberry is thus obtained.

Effect of Microorganisms on the Jellying Power of Fruit Juices. (C. R. Fellers, J. A. Clague and R. L. France.) The several species of yeasts and bacteria employed to date do not decompose pectin in fruit juices. However, several species of *Penicillium* and *Aspergillus* are very active pectin decomposers. Juice or pulp harboring these actively growing molds will not make satisfactory jelly or pectin.

Utilization of Onions by Canning and Drying. (C. R. Fellers.) This project has been inactive during the year except insofar as canned, dried, and pickled onions, previously packed, have been examined for keeping quality. There has been much commercial interest shown in the onion powder from cull onions which was developed several years ago.

Utilization of New England Fruits in Ice Cream. (C. R. Fellers and M. J. Mack. A report of this work was published in July as Bulletin 287. This co-operative project has been continued with a view to ascertaining whether strawberries still retain vitamin C after freezing and storage and incorporation into ice cream. Results clearly indicate that the high vitamin C content of fresh strawberries is retained in both frozen strawberries and strawberry ice cream.

Research on Dates. (C. R. Fellers, J. C. Clague and M. M. Cleveland.) The mineral composition of dates was determined and published in *Industrial and Engineering Chemistry, Analytical Edition*, 4:267-268, July 1932.

The souring of dates was found to be due to the growth of sugar-tolerant yeasts. Some of the results were published in the *Journal of Bacteriology* 23:63, January, 1932.

This work was made possible by a grant from the Hills Brothers Company of New York.

Vitamin Content of Blueberries. (C. R. Fellers and P. D. Isham.) Native, Maine, and Newfoundland blueberries were examined for vitamin C content, funds to help in this work having been furnished by the Birdseye Laboratories of Gloucester. The native tall-bush blueberry, fresh, frozen, or canned, was a good source of vitamin C, about 4 to 5 grams daily sufficing to protect guinea pigs from scurvy. However, the Maine and Newfoundland low-bush blueberries were not over one-third as active in this vitamin.

Effect of Fertilization on Vitamin A and C content of Asparagus. (C. R. Fellers, R. E. Young and P. D. Isham.) With the financial assistance of the Potash Export Company, My., asparagus grown at the Waltham Field Station was tested for vitamins A and C. The first season's results show that asparagus is a rich source of vitamin C, from 2 to 2.5 grams daily fully protecting guinea pigs from scurvy. The fresh asparagus also contained 5 to 7 units of vitamin A per gram. No conclusions may yet be drawn as to the effect of fertilizer treatment on vitamin content.

Canned Red Squill Rat Baits. (M. G. O'Connor and E. M. Mills, Bureau of Biological Survey, U. S. D. A.) This research, financed by the K-R-O Company of Springfield, Ohio, has shown that beef or horse meat, whiting, mackerel, haddock, and cereals, when mixed with red squill powder and canned, proved to be acceptable yet toxic baits for rats. Proper sterilization processes have been worked out for these canned baits.

DEPARTMENT OF OLERICULTURE

Ralph A. Van Meter in Charge

Asparagus Investigations. (Robert E. Young, Waltham.)

Fertilizers. The asparagus plots located at Waltham on a rather heavy soil did not produce as high yields in 1932 as those located on the lighter soils at Concord and Eastham. The spears at Waltham were very small, but the number of spears per plant was large. Older asparagus growing in another bed adjacent to these plots produced a large percentage of fancy spears, while almost no spears large enough to be graded as fancy were produced on the fertilizer plots. Nitrate of potash and sulfate of potash did not give as good results as muriate of potash. The difference in yield of the plots receiving the various nitrogen carriers was insignificant. Results this year show that potash is necessary for high yields.

The plots at Eastham, Massachusetts, on a light, gravelly soil gave very good results. Yields were high and the proportion of fancy spears was much greater than at Concord or Waltham. The plot receiving seaweed and superphosphate remains the highest-producing plot in the experiment, probably due to the capacity of this plot to hold moisture and plant food. Ten of the plots are duplicated on an acid soil. Some of the fertilizers gave better results on the acid soil, but ammonium sulfate gave only about 60 per cent as great a yield as on the regular plot.

The plots at Concord were cut for a period of two weeks this year. Last year they were not cut, due to poor growth of the previous season. The yield was very good for the short period of harvest. The plot that produced the highest yield was one receiving cottonseed meal as the source of nitrogen. This was followed closely by the plots which received the nitrogen as sulfate of ammonia and the phosphorus as basic slag. The remainder of the plots are grouped very close together in yield. The plot receiving no potash was notably low. Acidity tests made late in the fall show that the average pH has been raised from 4.5 to about 5.8.

In general the results obtained this season are much more promising than those of last season. There were some substitutions made in the fertilizer materials used, one being the use of calcium cyanamid, superphosphate, and potash in place of a mixture of ammonium phosphate and potash. The cyanamid was applied at the regular time, June 20. At that time there was a very heavy crop of weeds about three inches high covering the ground. A few days after this application of about 750 pounds of calcium cyanamid per acre, the weed growth had been completely killed. It apparently did not affect the asparagus plants.

Depth of Planting and Height of Cutting. The most significant result of this experiment seems to be the increased mortality where the asparagus roots are planted 6 and 8 inches deep. The decreased number of plants in these plots has reduced the yield. The roots planted at the shallow depth of 2 and 4 inches produced by far the most asparagus. If the yields are computed on the basis of a 100 per cent stand, however, the roots planted 8 inches deep rank first in yield, followed by the plots where the roots were planted 2, 4, and 6 inches deep, respectively. A

comparison of the stand counts in 1931 with those in 1932 shows that in the plots where the roots were planted 2 and 4 inches deep there was almost no loss of plants; while the plots where the roots were 6 to 8 inches deep continued to lose plants, there being approximately a 6 per cent loss in the latter case.

Of the three plots where the spears were cut with 4, 8, and 12 inches green, the largest yield was obtained from the plots cut with 12 inches green, and the plots with 8 inches of green were next. Yields from the plots cut with 4 inches of green were 11 per cent below the yields of the 12 inches of green. The yields this year were about the same as in 1931 except that the spread between the 4 inches and the 12 inches green was not so great. Definite conclusions cannot be drawn until the results of two or three seasons are available.

Seed Improvement. (Robert E. Young, Waltham.) Selfing to obtain pure lines was continued on five of the most promising strains of blue Hubbard squash. Some of these strains are nearly pure as shown by the uniformity of shape, color, wartiness, and thickness of flesh. These strains are losing vigor in that they do not produce yields equal to those of commercial strains. Some F_1 plants were grown from the cross of the most promising strains last year. The plants were selfed in order that a pure strain may be obtained if they continue to show promise.

The 1931 selections of Horticultural beans grown this past season proved to be a great improvement over any commercial variety that has been tried here. Two of these selections were very superior, and it is the intention to develop them further.

The market gardeners purchased about 750 pounds of the Field Station Hutchinson carrot seed this year. It is reported to be superior to commercial strains. There is some variation in the length of the carrot when it is grown in various types of soil. Plenty of this seed is available for distribution in 1933. The parent stock is being maintained at the Field Station to insure the same quality of seed from year to year.

The red sport of Oshkosh pepper that has been grown at the Field Station for the past few years has now been named the Waltham Beauty. The uniformity of the fruit of this pepper was greatly improved by the selections made in 1931. In 1932 there were plants among the selections that bore 20 marketable fruits. Plants grown on a one-eightieth acre plot for yield data produced an average of 12 peppers per plant, and the average weight of the peppers was 3.7 ounces. Selections were continued to improve the uniformity of the plants in height. Crosses made in the greenhouse last winter between the Waltham Beauty and the California Wonder, in the hope of producing a larger pepper, increased the size but at the expense of yield. As the Waltham Beauty seems superior to the varieties grown by the market gardener, it was decided not to wait until the pepper is perfected to distribute samples of the seed.

An ample supply of seed of the Bel-May lettuce is now available. Last season, 125 pounds of seed were grown in California for the Boston Market Gardeners Association. Plants are now being grown to maintain the seed stock, and from these selections will be made in an attempt to improve the frame formation.

Selections have been continued to improve the color and flesh of the Wyman Crosby beet. This variety has already proved to be very uniform in shape and size. The beets produced from the stock seed are uniform in shape and size and maintain their quality until quite large. Selections were made last season on the basis of size and color, as there seemed to be some indication of a correlation between them.

Systematic and Quality Studies of Varieties of Sweet Corn. (G. B. Snyder.) In the trial plots, 231 lots of sweet corn including 82 different named sorts were grown. Detailed records of each lot were taken in order to allow for definite classification and rating as commercial varieties for Massachusetts market gardeners. Many lots having distinct names were found to be either very similar to or synonymous with older standard varieties. Comparatively few of the varieties studied were found to be satisfactory for culture by the market gardener from a consideration of maturity, yield, size of stalk, size of ear, and color, size, and quality of kernel.

Refractive indexes and percentage-of-sugar readings were taken for 211 lots, 20 readings being taken for each lot. In the pre-milk stage of development sugar ranged from 12 to 16 per cent, and from pre-milk to soft-dough development varieties differed markedly, the high point in sugar ranging from 16 to 29 per cent. Strains of a variety, however, deviated very little from the average for the variety in percentage of sugar.

This year was the first of a three-year project.

Dark Center or Internal Breakdown of Swede Turnips. (G. B. Snyder and R. W. Donaldson.) Dark center of the Swede turnip is apparently physiological in character and non-parasitic. Histological studies indicate the condition as brownish or water-soaked areas in the parenchyma tissue between the vascular strands. The tissue of the cortex and cambium is not affected. In the advanced stages of dark center, the affected tissue becomes pithy and woody.

Field studies of dark center did not show any relationship between the condition and fertilizers, soil acidity, soil type, or crop rotation. A definite relationship, however, was noticed between soil moisture and dark center.

Series of crocks were set up in which varying quantities of animal manures and peat were applied to soils taken from infected fields in Berkshire and Barnstable Counties. In each series the soil moisture was regulated at low, medium, and high points. In every case the high organic soils having a medium to high moisture content produced plants showing little to no dark center. The low organic soils having a low percentage of moisture produced plants, the roots of which were decidedly affected by the disorder.

Taxonomic Studies of Eggplants. (G. B. Snyder.) During the past five years, 105 different named lots of eggplants have been under observation in the trial plots. Detailed records have been taken of each lot for plant and fruit characters, disease susceptibility, and commercial adaptability. From these observations and records a systematic monograph is being prepared.

DEPARTMENT OF PLANT AND ANIMAL CHEMISTRY

J. B. Lindsey in Charge

The Effect of Fertilizer and Cultural Treatment on the Composition of Havana Tobacco. (E. B. Holland and E. Bennett.) Various grades of Havana tobacco raised on the station plots in 1931 have been analyzed with a view to determining the effect of different amounts and forms of applied nitrogen on the composition of the web of both cured and sweat samples. The scope of the work has been broadened to include the determination of carbohydrates, with the expectation that additional studies may show some correlation between the nitrogen-carbon ratio of the web and its free-burning qualities.

To supplement this investigation popular brands of smoking tobacco and of cigarettes have been purchased in the local market and submitted to analysis.

The results show marked differences in the pipe tobaccos but a reasonable uniformity in the cigarette tobaccos.

Oil Sprays. (E. B. Holland.) Miscibles were prepared from five different lubricating oils ranging from spindle oils to a medium turbine. The process employed was the so-called spontaneous method using triethanolamine oleate as the emulsifying agent. The miscibles were applied in the orchard on the basis of 3 per cent oil by weight and gave satisfactory control of mites (index) in all cases with no apparent injury to buds or retardation of growth. The heavier, more viscous oils required a larger amount of emulsifying agent at an increased cost and were no more effective.

Nitrogen Fixation in the Presence of or as a Result of the Growth of Legumes versus Non-Legumes Under Certain Defined Agronomic Conditions. (F. W. Morse.) The crops grown this year (1932) were Hungarian millet and soy beans as non-legume and legume. Nitrogen was applied this year to Plots 5, 8, and 10, while Plots 7 and 9 were continued without any as in the past 50 years. This was the ninth crop since the beginning of this experiment, during which period Plot 6 has not received nitrogen while in previous years it had been dressed with ammonium sulfate like Plot 8.

Dry Matter and Nitrogen Removed from Non-Legume and Legume Areas in 1932
(Pounds per acre)

	Without Nitrogen		With Nitrogen	
	Dry Matter	Nitrogen	Dry Matter	Nitrogen
Hungarian Millet.....	3464	28.24	5385	52.78
Soy Beans.....	4029	104.77	4377	99.43

The non-leguminous millet responded to the nitrogen fertilizer with an increase of 1921 pounds of dry matter, equivalent to 2260 pounds millet hay per acre. The gain in nitrogen was 24.5 pounds, which is only 55 per cent of the 45 pounds applied per acre.

The leguminous soy beans gained 348 pounds of dry matter when nitrogen was applied, but the crop contained less nitrogen than that grown without any nitrogen in the fertilizer. The failure to take up nitrogen from the fertilizer has been observed in previous seasons with clover.

A summary of the nine crops grown on the legume sections of all the plots is here presented for each year of the experiment.

Dry Matter and Nitrogen removed from Legume Areas in 9 Years
(Pounds per acre)

Year	Crops	Without Nitrogen		With Nitrogen	
		Dry Matter	Nitrogen	Dry Matter	Nitrogen
1924	Clovers.....	3865	106.1	*3916	100.6
1925	Corn.....	3419	59.4	3422	58.5
1926	Soy Beans.....	3491	79.6	*3681	87.9
1927	Corn.....	2366	39.4	2353	40.9
1928	Clover and Weeds.....	2658	39.0	*2828	38.7
1929	Clover.....	3952	91.6	3624	81.3
1930	Millet.....	6187	78.9	*6920	89.5
1931	Peas and Oats.....	2510	44.6	2579	46.8
1932	Soy Beans.....	4029	104.8	*4377	99.4
Total		32477	643.4	33700	643.8

*Nitrogen applied in each of these years at the rate of 45 pounds per acre.

The net gain in nine years by the application of 225 pounds per acre of nitrogen was 1223 pounds of dry matter, while the nitrogen contained in the crops practically balanced. The fertilizer nitrogen appeared to stimulate growth at some stage, due possibly to its immediate availability, without ultimately increasing the content of the element except in the non-leguminous crops interspersed in the series. The leguminous crops from the plots without nitrogen, four times out of six, contained more nitrogen than those from the nitrogen group.

The results of this fertilizer experiment are now being prepared in more detail for publication. They suggest a new comparison between atmospheric nitrogen compounds synthesized by bacteria and those synthesized by factory processes by continuing the legumes and non-legumes, but substituting the newer nitrogen compounds for the former standard fertilizers.

Chemical Study of Cranberries. (F. W. Morse.) Twenty-three varieties of cranberries were analyzed, ten of which were from Wisconsin and thirteen from New Jersey. The samples were procured by Dr. H. J. Franklin in connection with his comparative studies of cranberry varieties. No information was available regarding dates of picking from the vines.

The analyses were made during January of this year (1932), and the berries were removed from cold storage as needed. Water, total sugar, and total acid were determined. Eight varieties were below 3 per cent in sugar content, which indicates fruit immature when picked. Eleven were between 3 and 3.5 per cent and one contained 4 per cent total sugar. Total acid ranged from 2.05 to 2.71 per cent which is within the limits found in past seasons.

Two varieties were notably superior in the proportion of sound fruit in January. Searls Jumbo from Wisconsin and Budds Blue from New Jersey were more than 85 per cent sound when sorted by hand. Fourteen were less than two-thirds sound, which shows the risk in holding cranberries in storage to extend the market period.

The two varieties above named illustrate the comparatively narrow difference in chemical composition between extreme types of cranberries. Searls Jumbo is a juicy berry of high quality. Budds Blue is dry and firm in texture. Analysis gave the following results in percentages.

	Water	Total Sugar	Total Acid
Searls Jumbo	87.9	4.02	2.35
Budds Blue	86.6	2.61	2.20

Astringent matter was determined in several varieties, of which these two represented the extreme range — Searls Jumbo, 0.19 per cent; Budds Blue, 0.37 per cent. The astringent matter in the cranberry appears to consist of a glucoside with a bitter taste rather than tannin, although qualitative tests show traces of tannin to be present.

Quinic acid was determined in 13 of the varieties by the tentative method mentioned last year. The range in approximate percentages was from 0.38 to 1.03 per cent. The two varieties mentioned above were practically alike, with approximately 0.7 per cent of the acid.

In the course of the cranberry studies, a quantity of the cranberry wax has been accumulated for the purpose of studying its properties.

Milk Substitutes in the Growing of Young Calves. (J. B. Lindsey.) This project has been completed and the manuscript prepared for publication. The general conclusion was that it is quite desirable to feed calves some liquid food until they are two months of age, and the time can well be extended a month

or more in case of delicate calves or when an extra growth impetus is desired. Nothing better was found for this purpose than powdered skim milk, now easily obtainable in the market at a reasonable price, followed later by white fish meal combined with our grain ration No. 5. The detailed method of procedure is given in the publication.

Two Systems of Dairy Cattle Feeding — High Roughage and Low Grain versus Low Roughage and High Grain. (J. B. Lindsey and J. G. Archibald.) This investigation has been completed and the results published in Bulletin 291.

Mineral Requirements for the Growth of Dairy Heifers. (J. B. Lindsey and J. G. Archibald.) Eighty-eight metabolism balance trials have been completed with twelve heifers on high and low phosphorus rations. The results of seventy-two of these trials with eight of the heifers have been calculated and sufficiently interpreted to enable determination of the next logical step in the investigation; but publication of even tentative conclusions at this time is not deemed justifiable.

Studies in the Chemistry of Pasture Grasses. (J. G. Archibald and E. Bennett.) A final report of three years' work on the chemical composition of grass from pasture plots managed according to the Hohenheim system appeared in the *Journal of Agricultural Research* 45: 627-640, November 15, 1932.

Results of a study of the distribution of the different forms of nitrogen in pasture grass have been brought together in an article entitled "Nitrogen Partition in Pasture Grass", which has recently been submitted for publication in the *Journal of Agricultural Research*, together with a companion article entitled "Influence of Drying and Grinding upon the Total, Amino and Ammonia Nitrogen Content of Grasses."

Field work in connection with the survey of natural pastures throughout the State was completed this year. One hundred samples of grass have been collected from typical unfertilized pastures on predominant soil types in the five western counties of the State. The analytical work on these samples is in progress and will be completed within a few weeks.

The study of the chemical composition of various species of grass has been continued this year. Forty additional samples from well-established plots of timothy, red top, Kentucky and Canada bluegrass, orchard grass, sheep fescue, Rhode Island bent, and white clover have been secured during the year, and reliable data are gradually being accumulated. The work will be continued at least another year before a formal report is made. However, the following tentative observations seem warranted at this time:

1. Orchard grass (*Dactylis glomerata*) has a remarkably high mineral content, phosphorus being about double that found in any other grass studied, and calcium being considerably higher than in most of the others.

2. The bent family of grasses (genus *Agrostis*), represented in this study by red top (*Agrostis alba*) and Rhode Island bent (*Agrostis canina*), seems to be characterized by a high content of calcium.

DEPARTMENT OF POMOLOGY

F. C. Sears in Charge

The experiment station orchard produced another good crop of peaches in 1932 following a remarkably mild winter. The lowest temperature reading in the orchard was exactly zero. During the ten years that this orchard has been of bearing age, the crop has failed only in 1924 and 1927, the cause of failure being

winterkilling of the fruit buds. Evidently the killing point is usually close to -15° F. Buds, especially of bud-hardy varieties, may withstand lower temperatures, while those of the more tender varieties may be badly killed at higher temperatures. The severity of bud killing depends on (1) the minimum temperature, (2) the variety, (3) the condition of the tree, and (4) conditions prevailing at the time of the temperature drop, such as wind, the rapidity of the drop, and the duration of the low temperature.

The apple crop was about 60 per cent larger than that of last year but was exceeded by that of 1930 also by about 60 per cent. Damage from insects and diseases in all well-sprayed orchards was unusually light.

The Interrelation of Stock and Scion in Apples. (J. K. Shaw.) Due to financial stress the Department has been obliged to allow the control of the main orchard of this project to pass to a commercial grower. Limited observations will still be made, but detailed experimental studies become impossible. Applications of muriate of potash to certain rows have not yet shown clearly that the "tip burn" referred to in the report of last year is due to potash deficiency. Observations on this will be continued. It is evident that water supply is a factor, but it is possible that lack of potash may also be a factor.

The young orchard of McIntosh and Wealthy on East Malling stocks set in 1928 continues to develop in a satisfactory way. It bore a scattering crop this year. McIntosh on Malling Stock 1 gives indications of being superior in early production, while Wealthy on the same stock does not produce so much on account of the very small trees. Stock 16 maintains its position as a standard stock and has produced well. Stock 9 promises to be a good dwarfing stock. The largest crop of Wealthy was on trees on Stock 4, and only McIntosh trees on Stock 1 exceeded those on Stock 4. This stock is not very highly regarded in England and may develop some fatal weakness, but experience thus far seems to indicate that here it is a good stock for producing large trees and for early production with these two varieties.

These stocks are being further multiplied, and more extensive tests of our desirable varieties on them are planned. It seems possible that some of them may be desirable for producing semi-dwarf trees, free from the objections to dwarf trees, which may have commercial value.

Tree Characters of Fruit Varieties. (J. K. Shaw and A. P. French.) The set of photographs and technical descriptions of more than 100 commercial varieties of apples referred to last year has been practically completed. Work along a similar line with commercial varieties of cherries has been started. Trees or buds of nearly forty varieties have been assembled. Seedlings of Japanese flowering cherries have been used as stocks. Certain types of this species produce viable seeds abundantly and give vigorous seedlings resembling Mazzard stocks. Further experience will show whether these are desirable for cherry stocks.

The usual certification work of the Massachusetts Fruit Growers' Association and the inspection of nursery trees for trueness to name have been continued although in somewhat reduced volume as compared with earlier years, due to the reduced demand for trees. The significance of this work is shown in the almost complete absence, now, of misnamed trees in the nurseries examined; whereas in the early years they were present, literally in thousands. The nurserymen report a marked reduction in the complaints of misnamed trees received from customers during the last few years. Such complaints must practically disappear in the future. The nurserymen having these examinations represent a rather small proportion of the total number; but the influence of this work extends beyond the

nurseries actually examined and there can be no doubt that the number of misnamed trees sold has been greatly reduced.

The Genetic Composition of Peaches. (J. S. Bailey and A. P. French.) Evidence has been obtained that in peaches there is linkage between the gene controlling stone adhesion and the gene controlling flesh toughness, with about 8 per cent crossing over. The Champion variety has an albino lethal character which acts as a simple Mendelian recessive. Among certain seedlings a new combination of leaf characters has appeared. Some individuals have very wavy leaves, deeply serrate margins, and globose glands. A paper on "The inheritance of certain characters in the peach" which is to appear in the 1932 *Report of the American Society for Horticultural Science*, will discuss these observations in more detail.

The breeding work was continued in the spring of 1932. This work was planned so as to give further information concerning the linkage relations between stone adhesion and toughness of flesh. Favorable weather conditions prevailed during the breeding season and a good crop of pits was obtained.

The two orchards of seedling peaches planted in 1928 had to be removed in the fall of 1932 because of a severe infection of peach yellows.

As a result of the peach breeding work in 1931, about 300 seedling peach trees are in the nursery ready to be set in the orchard in the spring of 1933.

Testing Methods of Pruning. (J. K. Shaw.) One of the orchards involved in this work has passed into the hands of a commercial grower for reasons previously mentioned. Some observation on the orchard may still be made. Work in the other orchard is still continued with no change in the trend of results.

Effect of Pruning Bearing Apple Trees. (J. K. Shaw and O. C. Roberts.) This experiment in an old bearing orchard has continued as in earlier years, comparison being made between heavy, light, and no pruning. Sizing and grading tests show in some cases better color and larger size in the apples from pruned trees and occasionally less insect infestation and disease, but the differences continue to be less than most fruit growers would expect.

Observations have been extended to include certain Rhode Island Greening, Wealthy, Ben Davis, and McIntosh trees, 35 years old, some of which are moderately pruned while others are left unpruned.

Comparison of Cultivation and Sod in a Bearing Orchard. (J. K. Shaw.) The amount of nitrate of soda applied to the sod plots was increased in the Spring of 1932 from 300 to 400 pounds per acre. There is some evidence that this may have resulted in yields larger than they would have been without this increase. Yet the plot in cultivation with nitrate continued to make a better showing; this gives further evidence that the sod-nitrogen program will not, over a period of years give maximum yields. The McIntosh trees on the cultivated nitrate-potash plot continue to yield better than those on the similar plot receiving nitrate alone, while the Baldwin trees do not. The increase in McIntosh is about 70 per cent, while the Baldwin trees have shown little or no increase. Further evidence is needed before it is safe to conclude that McIntosh has more definitely a potash requirement than Baldwin; yet it may be true.

The younger orchard included in this project has passed out of our control as previously stated.

Comparison of Clover Sod and Grass in a Sod Mulch Orchard. (J. K. Shaw.) The fertilizer treatments were continued as in previous years. The grass has been allowed to grow and the white clover has almost disappeared from

the phosphorus-potash-lime plots. These plots continue inferior to the complete fertilizer plots in yield. There is no conclusive evidence that the white clover brought in by the phosphorus-potash-lime treatment has benefited the trees, yet the trees have apparently produced better than they would have done had no fertilizer been applied. Wagener seems to have suffered more from lack of nitrogenous fertilizers than have Oldenburg and Wealthy.

Tests of Different Amounts of Nitrate of Soda. (J. K. Shaw.) This project has continued on the modified plan of fertilizing only in the off-bearing years. A complete fertilizer is used which contains nitrate of soda at the rate of 10, 17½ and 25 pounds per tree. The orchard is in sod. The crop in 1932 was less than that of 1930. This may have been due to weather conditions, the probable cause of the rather light Baldwin crop in 1932, or the omission of fertilizer may have been a factor. It is uncertain as yet whether this omission has improved the appearance of the fruit. Yields continue to be larger with larger amounts of nitrogen, and there is no marked difference in color of fruit.

Comparison of Cultivation and Heavy Mulching for Apples from the Different Plots. (J. K. Shaw.) The cultivated plots which received no fertilizer before 1931 were fertilized with nitrate of soda this year as in 1931. There is an apparent increase in yield of McIntosh, but Wealthy shows little if any increase. The yield of McIntosh, considering the smaller size of the trees, is now nearly if not quite as good as that from the mulched trees. The standard Wealthy trees on the cultivated plot with nitrate show some gain from the nitrate but those on doucin stock do not. This may be because they were already producing up to their limit. The comparison will be continued.

The Effects of Fertilizer Limitation on Fruit Plants. (J. K. Shaw.) The own-rooted McIntosh and Wealthy trees planted in 1931 have made fair growth, and the fertilizer applications were continued the same as last year. Conclusions as to whether these trees will behave the same as those previously grown on this field cannot yet be drawn.

Role of Potash and Lime in Fruit Tree Nutrition. (J. K. Shaw.) Further studies on the effect of acidifying soil from the long-time fertilizer test field known as the North Soil Test by applications of sulfur showed that lowering the pH value below 5.0 usually injures the growth of the seedling peach trees used as indicators, while lowering it below 4.0 kills the trees. The addition of mineral fertilizers is likely to be of little or no benefit, while the addition of organic ammoniates favors growth even in rather acid soils. Trees in soil from an apple orchard where apple trees are growing well, grew well under a pH of 4.2; however, when the pH was lowered to 3.8 the trees failed to grow. Raising the pH by additions of lime favored growth as in previous years.

Effect of Potash and Lime on Apple Trees. (J. K. Shaw.) This project has been carried on as in past years. There seems to be no evidence that lime has been of any benefit to the trees. It is possible that the addition of potash to nitrogen has now increased yields though there was no evidence of it in the earlier years. No indications of benefit to the trees from the application of phosphorus have yet appeared. More data and a careful analysis of all of it is necessary before final conclusions can be drawn.

Study of Varieties of Fruits. (J. K. Shaw and O. C. Roberts.) More new varieties came into bearing than in any previous year. Some are promising but few will take any prominent place among the standard varieties.

The Macoun apple bore more abundantly than in previous years. It is of good size and is nearly, if not quite, as good in quality as McIntosh. It is a real winter apple and fairly attractive in appearance. Its very short stem will cause no stem-bruises in the package. It is superior to Cortland in most respects. It seems to be the most promising candidate for a place as the much desired "Winter McIntosh."

Lobo is very attractive in appearance, being of a clear bright red but its quality is much inferior to McIntosh. As it is of nearly the same season it seems doubtful whether it can find a place in Massachusetts.

Early McIntosh and Milton showed no distinct superiority over previous years and it seems doubtful whether either becomes very valuable here.

Lodi is larger than Yellow Transparent and probably will stand handling a little better, but varieties of this type do not seem to be now in favor.

A red sport of Gravenstein originating in Ashby came into bearing this year. It is similar to the Washington type sent out by the New York Fruit Testing Association but does not seem in any way superior to it. Another sport, received from Lunenburg, while of somewhat higher color than Gravenstein, shows too little superiority to be very valuable.

Gallia Beauty again proved far superior in color to both Rome and Red Rome. The basin is wider, deeper, and more abrupt than in Rome, but otherwise it is similar in tree and fruit. There seems to be good reason why Gallia Beauty should replace Rome where such a variety is desired.

Melba is of Duchess season and superior to it for eating. It ripens unevenly and does not stand handling well. It may have value for local and roadside stand trade. Brock, Joyce and Pedro, three other McIntosh seedlings originating at Ottawa, are inferior in color and not too good in quality.

Scions claimed to represent a red and a blushed strain of McIntosh, topworked in the same tree, bore this year and proved the claim well founded. Apples of one strain were clearly striped and splashed while those from the other showed no sign of stripes or splashes. There was little difference in the total amount of color, yet the blushed strain is probably more desirable.

The raspberry variety plantation suffered badly from winter injury in 1931-32. Early in the spring the canes seemed in good condition but the leaf buds failed to start and the canes died back or were entirely killed. Some varieties suffered more than others. Newburgh and Monroe showed little or no injury. Possibly the rather severe cold in late winter and early spring following an unusually mild winter caused this injury.

The following varieties of red raspberries, originated at the Geneva New York Experiment Station, fruited in 1932:—

Newburgh has shown no mosaic as yet though other varieties located nearby have suffered more or less severely. It is vigorous, a good plant maker, and a heavy producer in mid-season of large firm berries of good quality. It is very promising.

Monroe (No. 2568). This variety also has as yet shown no mosaic diseases. It is vigorous, a good plant maker with practically smooth canes. It is a good producer, ripens its large, attractive, firm fruit early, and is of good quality. It is promising.

Nos. 2563, 2564, 2490 and 2491. These are similar to Monroe but all have suffered from mosaic diseases. The fruit ripens later and is poor in quality. They do not promise well here.

Some other varieties which fruited this year are as follows:

Lloyd George is vigorous and a good plant maker. It has not suffered from

mosaic but has shown some cane and spur blights. It ripens early and produces fairly well; the fruit is very large and of fairly good quality. It tends somewhat to be an everbearer. It should have value for the home garden.

Viking is vigorous and a good plant maker but suffered much from mosaic and winterkilled badly, seriously reducing the yield. When it does not winterkill it produces heavily of medium to large, firm berries of good quality in mid-season.

Chief is vigorous, a good plant maker, and has shown no mosaic. Fruit medium to large and of excellent quality. It is a good producer in mid-season, and seems very promising.

During the past season 41 varieties of strawberries were under observation. The following seemed to have desirable characteristics:—

Aberdeen is vigorous and a good plant maker. It is productive. The fruit is medium to large in size, attractive, medium to dark red in color, ripens from mid-season to late. It is worthy of a trial for both commercial and home use.

Bliss is one of the varieties originated at the New York Experiment Station. It is vigorous and a good plant maker, but somewhat susceptible to leaf spot. It ripens in late mid-season. The berries are large, attractive and of good quality.

Bouquet, also from the New York Experiment Station, is similar to Bliss but is earlier in season and seems to produce more heavily.

Commonwealth is an old variety but still worthy of consideration as a late variety which is its outstanding feature. It is moderately vigorous with light green foliage. It is fairly productive of large conic berries of fair quality.

First Quality is another old variety which maintains its popularity mainly because of its high quality. It is a fairly good producer of medium-sized berries in mid-season. It is susceptible to leaf spot.

Howard 17 (Premier) is too well known to need recommendation here.

Howard Supreme (Howard 25) is a newly introduced variety which continues to be one of the highest producers in the plantation. It is vigorous, dark green, and an excellent plant maker. The fruit is medium to large, dark red with red flesh and of good quality.

Mastodon continues to be the outstanding everbearer in the plantation. It is a good plant maker and a good producer of medium to large berries.

Steven's Late Champion is a good late strawberry but only fairly productive. The following varieties are of questionable value in Massachusetts for the reasons given:

Beacon - lacking in vigor and a poor producer.

Dunlap - small size of fruit.

Edmund Wilson - poor producer.

Improved Heflin - lacking in vigor, fruit small and of mediocre quality.

Town King - very poor in quality.

May Beauty - lacking in vigor; not productive and of only fair quality.

King Edward - excellent in quality and size, but lacking in productiveness; of value only for the home garden.

Marshall - the standard of quality but extremely unproductive.

Some other varieties grown, but concerning which there is yet insufficient evidence to judge their true worth, are seven varieties from the New York Experiment Station: Caledonia, Camden, Clermont, Culver, 4433, 4734, and 4813; also the Jupiter and Wyona.

Fruit Bud Formation in the Strawberry. (R. A. Van Meter.) This project is concerned with the effect on fruit-bud formation of nitrogen applications at various times during the latter part of the growing season. It was continued

during the past season along lines similar to those of the past four years. There has been no measurable effect where the plants are grown on the hill system with plenty of space between the plants.

A new bed was set in the spring of 1932 in which runner plants were developed and treated with nitrogen-carrying fertilizers. Nitrogenous fertilizers were also applied to alternating sections of strawberries in matted rows to study the effect of crowding upon nitrogen response. All plots are duplicated five times and all receive phosphorus and potassium.

Bud Mutations. (J. K. Shaw and W. H. Thies.) The collection of bud mutations of apple varieties was maintained. It will be several years before they come into bearing so that any persistent characteristics and their value can be determined.

Storage of McIntosh Apples Under Various Conditions. (O. C. Roberts cooperating with C. I. Gunness and W. R. Cole.) This project involves a study of the effect of the "blast" system of cold-air distribution on the keeping of McIntosh apples. A study is also being made of the optimum humidity for the satisfactory storage of apples in the cold storage and the air-cooled storage. Observations are being made in several commercial refrigerated and common storages in addition to those made in the college plant.

Study of Various Spray Materials. (O. C. Roberts cooperating with A. I. Bourne.) This is a continuation of the work that has been carried on here for several years whereby various spray materials on the market are given practical tests in the orchard to determine their efficiency and safety to the trees. Several of the wettable sulfur compounds appear to be suitable substitutes for liquid lime-sulfur in the post-calyx applications.

Blueberry Culture. (J. S. Bailey.) The propagation of blueberry plants was continued to increase the supply of plants, particularly of the newer varieties.

In the spring of 1932 a start was made on the establishment of a large plantation for the study of the cultural requirements of the blueberry. Observations on the relation of height of water table to the growth of blueberries were begun in this plantation.

The variety blueberry plantation was considerably enlarged to facilitate the more extensive testing of varieties under local conditions.

Cross Pollination and Sterility Studies with Certain Apple Varieties. (F. C. Sears, O. C. Roberts and others.) Work on the question of pollination of apples was continued for the eighth season. Special emphasis was placed on Macoun and Cortland, the two new varieties about which orchardists are most anxious to secure information. Both these varieties seem to be promising as pollinators for other varieties, but the evidence so far would seem to indicate that Cortland is inclined to be self sterile, like its parent the McIntosh.

DEPARTMENT OF POULTRY HUSBANDRY

J. C. Graham in Charge

Broodiness in Poultry. (F. A. Hays.) Non-broody and intense broody lines are continued. Both lines are being selected for the same degree of early maturity, intensity, absence of winter pause, and persistency. These lines will eventually differ only in the presence or absence of the broody instinct during the pullet laying year. In the 1931 generation there were 43 birds in the non-broody line. Of this number, 33 or 76.74 per cent were non-broody the first year and

their average annual egg production was 230 compared with an average production of 208 eggs for the 10 individuals going broody. The broody line was made up of 30 individuals. Three, or 10 per cent, were non-broody the first year. The mean egg production of the 30 birds was 177.

Deferred broodiness or the failure of the broody instinct to appear until after the first laying year causes considerable difficulty in the selection of breeding stock that is phenotypically broody or non-broody in the two lines.

The study of the mode of inheritance of degrees of broodiness is being continued as well as a study of the relation of broodiness to other characters affecting fecundity.

Breeding Poultry for Egg Production. (F. A. Hays and Ruby Sanborn.) The mean annual egg production of the last generation of this experiment was 221 eggs. The mortality rate in the laying houses was 34 per cent without culling and with all sisters of the families included. This flock was superior for intensity, but there was a greater percentage of broody birds than in the previous flock.

Egg size is being increased without the loss of high fecundity but more slowly than would be necessary if high intensity were given less consideration. Hatching records for 1932 were unsatisfactory because of a defective incubator.

Statistical Study of Heredity in Rhode Island Reds. (F. A. Hays and Ruby Sanborn.) Data have been prepared and published as follows: "Early and late feathering in Rhode Island Reds," *American Naturalist* 66: 286-287, 1932; "Types of intensity in Rhode Island Reds," Bulletin 286; "The relation of feather pigmentation to intensity of laying in Rhode Island Reds," Bulletin 288; "Hereditary and environmental factors affecting variability in egg production," Bulletin 289; "Relation between body weight and age at sexual maturity in Rhode Island Reds," *Poultry Science* 12:23-25, 1933; and "Relation of weight at sexual maturity to annual egg production," *Poultry Science* 12:25-26, 1933.

A Genetic Study of Rhode Island Red Color. (F. A. Hays.) The third generation of crosses between exhibition and production-bred Rhode Island Reds is now being carried in the laying houses. The F_1 generation was intermediate in plumage color, yet showed a rather wide range of color. The mean annual egg record of this generation was 191.

The F_2 generation exhibited the extreme range in color of the parent stock. The mean annual egg record of these birds was about 157.

The F_3 generation came from mating $F_2 \times F_2$ and from mating F_2 to parental stock. There is very definite segregation both of color pattern and of fecundity traits.

Determination of Genetic Laws Governing Results of Inbreeding. (F. A. Hays.) The first generation of daughters hatched in 1929 from sire on daughter matings averaged 180 eggs with a mean age at first egg of 216 days. The second generation from half-brother $\times$ sister matings had an average annual egg record of 190 with a mean age at sexual maturity of 192 days. A third generation of 24 birds hatched in 1931 had a mean annual production of 196 eggs and a mean age at first egg of 213 days. None of the third generation daughters in one of the three inbred lines could meet the standard for breeders and this line became extinct with this generation.

The value of inbred males mated to unrelated females to test prepotency is now being studied.

Factors Affecting Egg Weight and Shell Character in Domestic Fowl. (F. A. Hays.) The fifth generation of birds was hatched in 1932. The criterion

for selecting pullet breeders to produce this last generation was the ability to lay 52-gram, 57-gram and 59-gram eggs during the month of November. Previously these egg weights applied for the month of December. The daughters in these three lines are mated to three full brothers of distantly related stock each year. Egg size is being increased in all three lines but at a very slow rate in the 52-gram group.

DEPARTMENT OF VETERINARY SCIENCE

J. B. Lentz in Charge

Poultry Disease Elimination Law. (H. Van Roekel, K. L. Bullis, O. S. Flint, and Miriam K. Clarke.) During the 1931-32 pullorum disease testing season, 420,861 blood samples were tested by the macroscopic tube agglutination method. This number represented 377,191 chickens in 455 flocks. Among the samples tested, 0.90 per cent were positive. This is the lowest percentage of positive tests ever attained in this State. No positive tests were recorded in two counties. In six other counties there were less than 1 per cent of positive tests. The number of non-reacting flocks was increased to 355. Of these, 180 flocks, representing 157,516 birds, were 100 per cent tested. No reactors were detected among 1,034 birds other than chickens. These birds were distributed among 25 flocks. Chickens were tested on 19 of these premises, and reactors were found in five of the chicken flocks. Necropsies were performed on 117 birds for 61 flock owners. The necropsy service has been found valuable in determining the pullorum disease status of a flock in which only doubtful reactors are detected.

Pullorum Disease Investigations. (H. Van Roekel, K. L. Bullis, O. S. Flint, and Miriam K. Clarke.) Results of recent investigations concerning jellied blood samples, susceptibility of pheasants and guinea fowl, agglutinins in young chicks, avenues of infection, a comparison of diagnostic tests, and the most efficient use of the agglutination test in eradication are reported in Control Bulletin 63.

Laboratory Service - Pathology. (G. L. Dunlap and K. L. Bullis.) During the year, 1,042 specimens were examined for 263 people, of whom 96 made personal calls at the laboratory. The specimens were distributed as follows: — 1,013 chickens, 3 pigeons, 8 guinea pigs, 4 swine, 6 rabbits, 2 turkeys, 2 ducks, 1 calf, and 1 mink. The diseases encountered most frequently were pullorum disease, rachitis, so-called "range paralysis", parasitism, and tumors. Tuberculosis was diagnosed in one turkey and in one hen.

Farm and Station Bang Disease. In assisting this project, the laboratory tested 1,371 blood samples by the tube agglutination method.

Infectious Laryngotracheitis. (C. S. Gibbs.) The studies on chronic carriers of infectious laryngotracheitis have been completed, and 22 chronic carriers have been found in approximately 1,000 birds examined by intratracheal swabs. The length of time virus was eliminated by these carriers varied from 37 to 741 days.

Immunity studies have been continued through the year. It has been determined that immunity to infectious laryngotracheitis is acquired by direct contact with the causative agent and is not transmitted to the offspring, except in rare instances where the hens have laid eggs for hatching while passing through the acute stages of the disease. Also it has been found that infectious laryngotracheitis is primarily a disease of pullets and cockerels, older birds being more or less immune to it. This natural resistance should not be confused with artificial immunity.

Several methods of vaccinating pullets and cockerels against infectious laryngotracheitis have been studied, and the bursa of Fabricius appears to be the most satisfactory site for inoculating birds with attenuated viruses. The immunity produced by vaccination in the bursa of Fabricius is not lasting in all cases unless a standard vaccine is used. As yet no simple, inexpensive process for standardizing the vaccine for infectious laryngotracheitis has been discovered, and for this reason no practical method for vaccinating birds on a large scale is recommended.

Four spraying solutions recommended for infectious laryngotracheitis have been tried out in the laboratory to determine their pharmacological action upon the respiratory system. These sprays were not found specific for infectious laryngotracheitis, since they did not destroy the virus in the tracheas of acute cases and chronic carriers.

A plan for the eradication and control of infectious laryngotracheitis has been worked out by laboratory studies and field tests and is recommended until a more satisfactory way of handling the disease is discovered. The plan follows:

*The Massachusetts Plan for the Eradication and Control of
Infectious Laryngotracheitis*

1. All birds on the premises that have had infectious laryngotracheitis or been exposed to it should be condemned and disposed of at the end of the hatching season or at any other time most convenient to the owner for the expedient eradication of the disease.
2. Incubators and brooders should be cleaned, disinfected, and isolated some distance from the condemned birds.
3. Chicks that have not been exposed to infectious laryngotracheitis may be kept for restocking, provided they are entirely separate from the condemned birds and the premises occupied by them.
4. All buildings occupied by the condemned birds should be thoroughly cleaned and disinfected as soon as possible after they are vacated.
5. The houses and yards after cleaning and disinfecting should be opened to the air and sunshine and left vacant for two months or longer.
6. Overalls and shoes worn around the condemned birds or on the premises occupied by them should not be used in the houses, on the range, handling feed, or in caring for chicks for re-stocking, unless laundered or thoroughly disinfected.
7. Utensils and equipment used around the condemned birds or in cleaning and disinfecting the premises occupied by them should not be used in the houses or on the range where the chicks for re-stocking are kept unless said utensils and equipment have been thoroughly cleaned and disinfected.
8. Permitted Disinfectants should be used as directed for disinfecting all poultry houses, utensils, and equipment.
9. New stock should be introduced only from absolutely clean flocks or from the poultrymen's own hatchings which have been adequately protected from infection.
10. The subsequent re-introduction of infectious laryngotracheitis should be carefully guarded against.

Twenty-seven poultrymen are known to have tried the plan as recommended or some modification of it. Twenty-three of them succeeded in eradicating the disease completely and four failed. The four failures were found to be due either to improper cleaning and disinfection, or to the lack of sufficient airing and sunning of the house and yards.

Infectious Bronchitis. (C. S. Gibbs.) An epizootic of infectious bronchitis, due to a streptococcus, has been found affecting a flock of hens and roosters. The

causative agent was isolated from the bronchial tubes and tracheas of infected birds by means of blood agar plates, and transmitted in series to susceptible fowls and roosters, and successfully recovered from each case.

Culturally, morphologically, and serologically the streptococcus resembles the microorganism isolated from a similar condition in baby chicks reported in Bulletin 280, p. 242, 1932, except that the former organism affected adult birds and the latter was found only in baby chicks. Laboratory studies indicated that this was an instance of biological adaptation which could be changed at will.

The microorganism isolated in these epizootics is a haemoglobinophilic streptococcus and is responsible for a condition which has been called infectious bronchitis. The prevalence of this disease in the poultry population at large has not been determined. However, laboratory studies indicate that the mortality and loss in egg production may not be as serious as in infectious laryngotracheitis.

Avian Paralysis or Neurolymphomatosis. (C. S. Gibbs.) Pathological studies of avian paralysis have been continued through the year, and perivascular infiltration of round cells in the capillaries carrying blood and lymph to the nerves has been observed in incipient stages of the disease. Also metastatic infection of nerves from sarcomas in splanchnic tissue, by means of round cells conveyed in the blood and lymph vessels, has been evident in selected cases. A comparative pathological study of neurolymphomatosis and lymphatic leukemia has been undertaken. Up to the present it has not been possible to differentiate the hyperplastic tissues in lymphatic leukemia from certain forms of lymphoblastoma, although neurolymphomatosis may be readily differentiated from both on the basis of blood counts, differential blood stains, and gross pathology.

Cases of neurolymphomatosis from flocks in which the disease has been introduced comparatively recently show more inflammation and generalized lesions than those from flocks in which the disease has existed for a number of years.

WALTHAM FIELD STATION

(Waltham, Massachusetts)

Ray M. Koon in Charge

The research of this Station has been projected principally along the same lines as in 1931. As rapidly as conclusive results on any phase of a project have been obtained, they have been released to the commercial growers for application to their problems, without waiting until the completion of the entire project. For reports on experiments conducted at this Station, in addition to those listed under this caption, see reports of the Departments of Botany, Entomology, Floriculture, and Olericulture.

An increase of 50 per cent in the total number of visitors to the Field Station was recorded in 1932 over the year previous. During the year 2446 persons came to the Station for personal conferences with members of the staff regarding troubles threatening their commercial enterprises, or in quest of assistance with problems relating to amateur horticulture as it is practiced about the home. Telephone inquiries have numbered 2114; and 2748 letters (not circular) and over 2000 bulletins, leaflets, and mimeographs have gone out in answer to requests for information.

In March a two-day course offered to commercial flower producers and retail florists was attended by 225. A school for home gardeners, conducted for two days last April, was attended by 800 persons from 54 cities and towns in the eastern part of the State and several cities in Maine, New Hampshire, and Rhode Island.

The Boston Market Gardeners Association has continued to use the Field Station as headquarters for their monthly executive committee meetings.

The annual Field Day was held on August 3 with 888 farmers attending.

The Plant House. (P. W. Dempsey.) Interest in the plant house is increasing. Growers of both ornamental and vegetable plants are finding it of much value, and many amateur gardeners are also finding this type of structure economical to build and operate, and derive considerable pleasure from their winter garden. A new up-to-date plant house was built during the fall according to our latest plans, and an effort is being made to interest commercial concerns to standardize all the parts of the structure they sell.

Growers who have lost their source of heat (fresh manure) are now interested in installing hot water heating systems in their frames. The plant house offers such superior conditions for growing seedlings that the grower is advised to construct a plant house and use his frames to increase his capacity.

Electricity as a Source of Heat in the Hotbed and Propagating Bench. (P. W. Dempsey.) Work on this project was continued in both the greenhouse and hotbed. Interest on the part of growers is bound to increase as they become acquainted with this mild, controlled source of heat. Improvements in methods of use and type of equipment are constantly being made. Commercial growers in several states have installed rather extensive outfits.

From the results of this work it is recommended that growers go slowly in making an investment in installation and equipment, a trial bed or bench of from 4 to 10 sash being suggested. Operating costs at a current rate of 3 cents per kilowatt hour have been rather high. The cost of maintaining the temperature of a propagating bench (sand) 3 feet wide and 5 inches deep at 60° F. with the air temperature 50° F. was one cent for each running foot each 24 hours. Cost of the hotbed was \$1.60 per sash for the season March 10 to May 20, with the minimum temperature 45° F. Hot water has proved as satisfactory and much lower in operating cost -- 50 cents per sash. Work will be continued to gain more essential knowledge of advantage to the grower.

Vegetable Variety Trials. (P. W. Dempsey.) Over fifty strains of sweet corn were planted on two different dates. The outstanding feature in this year's trials was the number of new strains of Early Golden Market, introduced some seven years ago by Gill Brothers of Portland, Oregon, appearing under different names -- Early Sensation, Yellow Sensation, Extra Early Yellow, Golden Hummer, Extra Early Golden, and others. These strains are certain to become popular since they all mature before Bantam and bear a large ear of Bantam quality. Golden Sunshine is but little different in general characteristics and is constantly gaining in popularity. In later-maturing varieties there is considerable interest in "Top-Crossed" and "Inbred" strains of sweet corn. The strains mature a heavy crop of excellent-quality ears of even size, and are of particular value for the cannery.

Forty-four strains and varieties of beets were seeded in two plantings. More attention is being paid to inside color of the root than formerly. Ohio Canner is a variety showing promise for a particular trade. It is rather small in size, of excellent quality, very dark in color, and matures evenly.

Eighty strains and varieties of tomatoes were planted, half of the plants of each strain being staked and half grown flat. The new variety, Pritchard, introduced by the United States Department of Agriculture, did not show up as well as ex-

pected. Seventy-five per cent of the staked plants of this variety were determinate, some producing only one cluster of fruit, and others ranging from two to four clusters. Grown flat, the growth was normal. Fruit was of good size and quality, but a large proportion showed an objectionable yellow under-color similar to that of Break O'Day. There is always much interest in our tomato trials on the part of all growers who visit the Field Station. Peculiar as it may seem, there is no variety which is outstanding year after year; therefore, it is difficult to make definite variety or strain recommendations to growers. Seasonal conditions affect the growth of tomatoes considerably.

Beans were included in the trials this year on account of the many new variety names found in the seed catalogues. There is a distinct trend in popularity toward the more extensive use of the round-podded varieties. Although the flat podded varieties Bountiful (green pod) and Sure Crop (wax) are still the most popular, there is more interest than ever in Pencil Pod Wax and the new round pod varieties Tendergreen and Stringless Black Valentine.

Twenty celery varieties made an exceptionally good growth in spite of the abnormally dry season. New variety names appearing this year in our trials were Golden Phenomenal, Golden Detroit, Utah Golden Crisp, Salt Lake, and Florida Queen. It will be necessary to try all of these again before final judgment is passed. Up to date, there is no reason for recommending that our growers make any change from the varieties they are now growing -- Pascal for winter and Golden Plume or Wonderful for summer and fall.

New names appearing on the variety lists of carrots also made it imperative to conduct a carrot variety test this year. Perfection, Pride of Denmark, and Imperator are very similar in type to the Coreless although much larger. All are uneven in size and type. Both favorable and unfavorable comments have been received from growers on all these varieties, so it is recommended that a grower determine just how each one performs under his conditions before planting any quantity. The new Red Cored Chantenay is certainly a big improvement in quality and the type is exceptionally uniform. Tendersweet, apparently a strain of Red Intermediate, is a carrot of exceptional quality and similar in color to the Red Cored Chantenay. Many local market gardeners are now using the Hutchinson variety for bunching, in place of the Chantenay and Danvers varieties formerly used for this purpose.

COOPERATIVE CRANBERRY INVESTIGATIONS

Conducted by the Bureau of Plant Industry, United States Department of Agriculture, in cooperation with the Massachusetts Agricultural Experiment Station. H. F. Bergman, Senior Pathologist, U.S.D.A., in Charge.

Development of Strains of Cranberry Resistant to False Blossom. (H. F. Bergman, W. E. Truran, and Jos. L. Kelley.) Reciprocal crosses between Early Blacks and McFarlins were made in July 1932. The crosses of Early Black by McFarlin were unsuccessful. The reciprocal cross of McFarlin by Early Black yielded a considerable number of fruits which matured normally. In order to determine the possible existence of resistant strains within single varieties, a number of flowers of the varieties Early Black, McFarlin, and Howes were self-pollinated. No fruits were obtained from selfed flowers of Early Black, but fruits were obtained from both the other varieties.

During September some fifty selections of wild cranberries were made in Maine. These selected wild vines were taken to East Wareham where they are being held over winter to be propagated in 1933. Several of the selected wild vines show very desirable vine and fruit characteristics.

Oxygen Content of Flooding Water in Relation to Injury to Cranberry Vines. (H. F. Bergman and W. E. Truran.) Some experiments to determine the effect of absence of oxygen in winter-flooding water on the development of terminal and fruiting buds during the following growing season failed because of unfavorable weather conditions. Several hundred buds of Early Blacks and Howes on the State Bog were tagged and their development was followed through the season. Large terminal buds tended to produce more fruits than either medium or small terminal buds. This tendency was more evident in Howes than in Early Blacks.

Regeneration of False Blossom Bogs. (H. F. Bergman and Jos. L. Kelley.) In cooperation with growers, two areas of bog badly infested with false blossom were sprayed in July with commercial weed killer (probably sodium arsenite) diluted 1:30 and applied at the rate of 600 to 800 gallons per acre. This treatment appears to be very satisfactory.

June Flooding for Fireworm Control. (H. F. Bergman, W. E. Truran, and Jos. L. Kelley.) Severe injury to flower buds and growing tips, due to low oxygen content in the flooding water, was observed in one bog during the flooding period for fireworm control. The lowest oxygen content found was 1.9 cc. per liter. Fireworms were apparently completely killed. No injury was observed on two other bogs. From experiments it appears that fireworms can be killed by submergence for 12 hours in water at a temperature of 15° to 20° C., and an oxygen content of less than 4 cc. per liter. An oxygen content of less than 1.0 cc. per liter for 5 to 6 hours causes injury to flower buds and growing tips.

June Flooding for Leafhopper Control. (H. F. Bergman and W. E. Truran.) Flooding for 16 to 18 hours killed about 75 per cent of the leafhoppers on one bog. The oxygen content of the water did not fall below 3.5 cc. per liter. No bud injury was observed. Flooding for 12 to 15 hours, on another bog, killed only about 50 per cent of the leafhoppers. The lowest oxygen values here were 3.5 to 4.0 cc. per liter.

Investigations on the Effect of Copper Residues from Bordeaux Spray on the Growth of Cranberry Vines. (H. F. Bergman and W. E. Truran.) The greatest amount of copper, which varies from 150 to 200 milligrams per kilogram of dry soil, is found in heavily sprayed bogs with a peat substratum. There is much less copper in soils of very wet bogs and of those with a sand substratum. The amount of copper in vines varies from 50 to 100 milligrams per kilogram of dry vines. The leaves ordinarily contain one and one-half to two times as much copper as the stems, for the same weight of material. In one experiment copper sulfate was applied directly to the soil in amounts equivalent to 800, 1200, 1600, and 2400 pounds per acre, without injury to the vines and with no apparent reduction in yield.

Spraying Experiments with Bordeaux and Organic Mercurial Sprays. (H. F. Bergman, W. E. Truran, and Jos. L. Kelley.) Spray plots were located on four separate bogs. Bordeaux made up by the 4-4-50 formula, with chemically hydrated lime, and applied at the rate of 350 to 400 gallons per acre was used on all bogs. Two organic mercurial sprays were used on one bog. The reduction

in the amount of rot showed a direct relation to the number of applications of the spray. The two mercurial sprays used gave as good control of fungous rots as the Bordeaux.

Storage Test of Cranberries. (H. F. Bergman, W. E. Truran, and Jos. L. Kelley.) Berries were stored in the basement of the State Bog building, at air temperature, which on November 1 was about 15° C., and later dropped to about 5° C. Cranberries from sprayed plots showed less loss from fungous rots than those from unsprayed plots. In the berries from two of the bogs this difference did not become apparent until about January.

COOPERATIVE TOBACCO INVESTIGATIONS

Conducted by the Bureau of Plant Industry, United States Department of Agriculture, in Cooperation with the Massachusetts Agricultural Experiment Station.

C. V. Kightlinger, U. S. D. A., in Charge

Black Root-Rot. (C. V. Kightlinger.) In continuation experiments numerous strains of Havana Seed tobacco were grown in the field during 1931 in a further attempt to find strains that will be satisfactory under Connecticut Valley conditions for resistance to black root-rot, type of plant, type and quality of leaf, and producing capacity. One strain was Havana Seed of the sort that is grown more commonly in the Connecticut Valley, known to be susceptible to black root-rot, but acceptable for type of plant and type and quality of leaf. This strain was used as a standard of comparison for types. One strain was Havana Seed 142A3, known to be satisfactorily resistant to black root-rot, and was used as a standard of comparison for resistance. Of the new strains being tested, eight had been grown in 1930, and seven were grown for the first time in 1931. These strains were all grown on land which in one case was free or nearly free of *Thielavia basicola*, and in another case was heavily infested with *Thielavia basicola*. Of the fifteen new strains tested in 1931 under these circumstances, eight were selected as apparently deserving further testing.

The production of these eight strains when grown on soil free or nearly free of *Thielavia basicola*, was as follows:

	Yields per Acre - lbs.	Grade Index	Crop Index	
Havana Seed - Common strain.....	1868	.431	805.	
Havana Seed 142A3.....	1828	.436	797.	
Havana Seed - new strains.....	# 5	2106	.474	998.
	# 13	1946	.475	924.
	# 14	1901	.482	916.
	# 9	1897	.480	911.
	# 22	1922	.460	884.
	# 10	1807	.478	864.
	# 23	1899	.445	845.
	# 15	1818	.452	822.

The production of these same eight strains when grown on soil heavily infested with *Thielavia basicola*, with each strain having its own check of common Havana grown in adjacent rows, was as follows:

	Yields per Acre - lbs.	Grade Index	Crop Index
Havana Seed 142A3.....	2189	.470	1029.
Common Havana (check).....	1237	.314	388.
Havana Seed - new strains.....	# 5	2298	.470
	check	1315	.320
	# 13	2523	.459
	check	1415	.350
	# 14	2315	.430
	check	1421	.340
	# 9	1925	.388
	check	1285	.312
	# 22	1892	.341
	check	1014	.277
	# 10	2023	.387
	check	1364	.313
	# 23	2109	.411
	check	1126	.290
	# 15	1895	.407
	check	1410	.309

Some of these newer strains deserve testing on a considerably larger scale in numerous places in the Connecticut Valley to determine their excellence in practical production.

Note: Grade Index is a number expressing the grading of all the tobacco produced by a strain in an experiment. It is based upon the percentage of grades, and the relative percentage values of these different grades, as given below:

Light wrappers.....	1.00	Long darks (19" & longer)....	.30
Medium wrappers.....	.60	Dark stemming (17" & shorter). .20	
Long seconds (19" & longer)...	.60	Fillers.....	.10
Short seconds (17" & shorter)...	.30	Brokes.....	.10

Grade index is derived by multiplying the percentage yield of each grade by its respective price in the above schedule, adding the products, and dividing by 100.

Crop index is a number expressing crop value and is derived by multiplying the total acre production of tobacco in pounds by the grade index value of that particular tobacco.

Grade index and crop index and the adopted price relationships given above do not necessarily represent commercial values and prices.

PUBLICATIONS

Bulletins

- 280 Annual Report for the Fiscal Year Ending November 30, 1931. 64 pp. February, 1932.

The main purpose of this report is to provide an opportunity for presenting in published form, recent results from experimentation in fields or on projects where progress has not been such as to justify the general and definite conclusions necessary to meet the requirements of bulletin or journal.

- 281 Experiments with Permanent Pastures. A. B. Beaumont. 36 pp. illus. April, 1932.

A large proportion of the farm land of Massachusetts consists of stony uplands more suitable for permanent pastures than for tilled crops. The improvement of pastures by top-dressing with fertilizers offers attractive possibilities; and the fact that large areas have already reverted to forest shows what must happen to existing pastures if fertilizer is not applied, or if the price of milk is too low to make such application profitable. A pasture which is weedy or run-down because of a lack of plant food can be brought back to productive condition only by the use of plant food. On the basis of the experiments reported, it is recommended that 1 ton of ground limestone (or its equivalent in hydrated lime) be applied every 6 years; 480 pounds of 16 per cent superphosphate and 160 pounds of muriate of potash, every 3 years; and 160 pounds of nitrate of soda, annually. At prices prevailing early in 1932, this treatment can be made by an annual investment of \$5 to \$10 an acre and it is believed will yield a fair return under Massachusetts conditions.

- 282 Relation Between Egg Quality and Price. Adrian H. Lindsey and Hubert W. Yount. 22 pp. May, 1932.

In order that the poultryman may feel justified in placing special emphasis on the quality of eggs and secure in making the extra expenditure involved in producing a higher grade product, he should have some assurance that quality values are recognized by the consumer. The most definite and significant relationship discovered from this analysis is that prices are directly related to weight under all conditions. That weight is a significant factor is not new, but it has not been known that weight is more important at one season of the year than another and that the premiums which are paid for weight are fairly definite. If premiums are known, it will be possible to determine by further research whether the production of large eggs is profitable.

- 283 Downy Mildew of Cucumbers. William L. Doran. 22 pp. May, 1932.

Downy mildew is a common and important disease of cucumbers in Massachusetts as well as in most of the eastern and southern states. The investigation included the source of primary infection, the effect of climatic factors, and the prevention of infection by the use of fungicides. All available evidence indicates that the fungus probably reaches Massachusetts from states farther south after a gradual northern movement by the aid of wind. Two to three hours on a leaf wet with rain or dew is enough for the germination of most of the conidia of this fungus, and five hours is sufficient to produce infection of leaves. In both field and greenhouse, copper fungicides are to be preferred to sulfur for the control of downy mildew. In Massachusetts the first application of a copper fungicide should be made, in the field, about July 25, and later applications should be made at weekly intervals. Bordeaux mixture 3:3:50 is a sufficient concentration for use in the field. Bordeaux 1:1:50 prevented infection of greenhouse cucumbers, and this is the concentration recommended for use in greenhouses.

- 284 Questions and Answers Concerning Pullorum Disease. H. Van Roekel. 23 pp. illus. May, 1932.

The purpose of this bulletin is to make available for the Massachusetts poultry industry information which will aid the poultrymen to improve their methods of establishing and maintaining pullorum disease-free flocks. The subjects covered are history and distribution of the disease, its nature and dissemination, control and eradication, including sanitary measures recommended.

- 285 The Relation of Temperature to the Activity and Control of the Plum Curculio in Apples. W. D. Whitcomb. 16 pp. illus. June, 1932.

The plum curculio frequently does more damage to apples in Massachusetts than all other insects together. As a result of the heavy loss to fruit growers, studies of the factors which influence the activity of this insect were conducted at Waltham. Early in the work temperature was found to play an important part in the problem of control, and the more recent studies have centered around this factor. Recommendations for Massachusetts, based on these studies, are: After the blossom petals have fallen, apply a special spray or dust in the first period of warm weather when the maximum temperature reaches 75° F. or higher and such temperatures promise to continue for 2 or more successive days. Use 4 or 5 pounds of lead arsenate in 100 gallons of spray, preferably with the addition of 1 pint of fish oil or linseed oil as a spreader or sticker. Except in severe infestations, 85-15 sulfur-lead arsenate dust can be substituted for the spray. When there are two distinct periods of high temperature within 15 days after the proper time for the calyx spray, apply a spray or dust in each period, using the same materials, and determining the time of application by the same temperature requirements as before. On scab susceptible varieties, or where the addition of a fungicide is desirable for any reason, liquid lime-sulfur or a similar material can

be added to the spray without danger of greatly decreasing the efficiency of the mixture for combating the plum curculio.

- 286 Types of Intensity in Rhode Island Reds. F. A. Hays and Ruby Sanborn. 11 pp. June, 1932.

Intensity or rate of laying is one of the very important inherited characters affecting annual egg production in poultry. Various methods have been used for measuring intensity, and there is an increasing need for more information concerning the relative merits of the different measures as well as for definite data concerning the relation of intensity to other traits affecting fecundity. Interrelations between the rate of laying in three different seasons and the relative values of six short-time measures of intensity are considered in this report. It was found that the most significant short-time measure of intensity is spring clutch size, but no short-time measure of intensity is as accurate as the mean clutch size for the entire year.

- 287 Frozen Fruits and Their Utilization in Frozen Dairy Products. M. J. Mack and C. R. Fellers. 28 pp. illus. July, 1932.

The frozen-pack method is used annually to preserve large quantities of fruit, much of which is later used for flavoring ice cream. Fruits used for this purpose have a very pronounced influence on the quality of the final product, but very little is known regarding the most satisfactory ways of processing fruit for utilization in frozen dairy products. The plan of the investigation was to prepare experimental packs of the fruits in one-gallon cans, freeze these under known conditions, store for approximately one year, thaw, examine carefully, and finally use the fruit in the manufacture of fruit ice creams, sherbets, and ices. The greater part of the study was with strawberries, but raspberries, peaches, cherries, and a few other varieties of minor importance were included.

- 288 The Relation of Feather Pigmentation to Intensity of Laying in Rhode Island Reds. F. A. Hays. 8 pp. October, 1932.

Deep rich plumage color and high winter laying intensity in Rhode Island Reds are desirable characters which can be influenced by breeding. This investigation was undertaken to determine to what extent both of these characters can be developed simultaneously by the breeder. It would seem to be a laborious process to establish uniform deep pigmentation and high intensity in a flock, but a medium shade of red should be maintained without difficulty.

- 289 Hereditary and Environmental Factors Affecting Variability in Egg Production. F. A. Hays. 12 pp. illus. December, 1932.

It is a well-known fact that both hereditary and environmental factors affect the number of eggs laid by a hen. Evidence is not conclusive on many points, however, and experimental data have not been reported to furnish information concerning the quantitative variation of specific fecundity traits from generation to generation. There is at present an outstanding need of a clear-cut distinction between the effects on fecundity of heritage and environment. Such a problem offers many difficulties, the most outstanding of which is the lack of any measure of fecundity in males. This report concerns itself with results obtained in carrying three lines of birds through four generations. Consideration is given to variability in five inherited fecundity characters: sexual maturity, intensity, winter pause duration, total days broody, and persistency. Variability in winter and annual egg records is also recorded. Such environmental influences as hatching date, increase or decrease in body weight, and daily house temperature are considered in relation to egg production and the relative importance of each is discussed.

- 290 The Story of Field A of the Massachusetts Agricultural Experiment Station: A Review of Experiments with Nitrogen Fertilizers. Fred W. Morse. 23 pp. illus. November, 1932.

The year 1932 marks the fiftieth anniversary of the formal organization of agricultural research at Massachusetts State College. It was in November, 1882, that the Experiment Station was established, and field plot experiments begun the next year represent some of the first activities. It seems fitting, therefore, after this fifty-year period, that results from this work be compiled and recorded in permanent form. Field A was laid out in 1883 on "run out" hay land and included eleven plots of one-tenth acre each. Seven successive crops of corn were grown from 1883 to 1889, to study the effects of different forms and kinds of plant food. The earlier harvests showed potash to be the most needed fertilizer; the later ones indicated that a complete fertilizer had become necessary. Four standard types of nitrogen fertilizers -- nitrate of soda, sulfate of ammonia, dried blood or fish or cyanamid, and stable manure -- were compared in 1889, and the comparison was continued with minor

changes until 1921. A variety of crops was grown, and tables show results obtained with oats, soy beans, potatoes, hay, corn, and miscellaneous crops. The value of Field A to agriculture is its history of the diversity of results. Back of any subsequent work upon it are authentic records of each plot, of which no similar records were to be had when the field was laid out.

- 291 Two Systems of Feeding Dairy Cows: High Roughage and Low Grain versus Low Roughage and High Grain. J. B. Lindsey and J. G. Archibald. 15 pp. December, 1932.

The amount of grain to be fed to cows is a question of perennial interest to farmers, particularly in a state like Massachusetts where grain is bought outright, while roughage is grown at home. Though much has been written on the subject, it has been largely opinion unsupported by experimental evidence. This bulletin reports the results of a long-time experiment (October 1, 1928 to March 31, 1932) conducted at this station. Viewing the results as a whole, the low roughage group of cows had a rather better record. They looked thriftier, put on more flesh, milked more freely, maintained their production better from year to year, maintained their average test better, and were more nearly normal in their reproductive function. It was evident that cows will not produce to the limit of their ability on a high roughage system of feeding. Which method of feeding will produce milk more economically, however, depends very largely on local conditions as to production and markets, and in a large measure is a problem to be solved by the individual farmer.

- 292 Carbon Disulfide Emulsion for the Control of the Root-Knot Nematode. E. F. Guba. 16 pp. illus. December, 1932.

Many greenhouse establishments lack the necessary means for sterilizing soil with steam or hot water. Even where these methods are practiced with successful results, they are laborious and slow and require expensive equipment. Experiments have been conducted which show that the use of carbon disulfide emulsion as a soil drench in greenhouses can be relied upon to greatly reduce the root-knot nematode as a factor causing crop loss, at a cost of approximately \$0.009 per square foot for chemicals. Carbon disulfide emulsion is compatible with formaldehyde. A stock emulsion containing 68 per cent carbon disulfide, 26 per cent water, and 6 per cent rosin-fish-oil soap in a 1:50 concentration for controlling the root-knot nematode, with the addition of 2/3 gallon of formaldehyde if soil-inhabiting fungi are a factor, is effective. The addition of formaldehyde adds about \$0.007 per square foot to the cost of the treatment.

Control Bulletins

- 62 Seed Inspection. F. A. McLaughlin and Margaret E. Nagle. 47 pp. February, 1932.
- 63 Twelfth Annual Report on Eradication of Pullorum Disease in Massachusetts. H. Van Roekel, K. L. Bullis, O. S. Flint and Miriam K. Clarke. 80 pp. September, 1932.
- 64 Inspection of Commercial Feedstuffs. Philip H. Smith. 48 pp. September, 1932.
- 65 Inspection of Commercial Fertilizers. H. D. Haskins. 50 pp. October, 1932.
- 66 Inspection of Agricultural Lime Products. H. D. Haskins. 8 pp. December, 1932.

Meteorological Reports

- 517 - 528, inclusive. Monthly reports giving daily weather records, together with monthly and annual summaries. C. I. Gunness. 4 pp. each.

Reports of Investigation in Journals

(Numbered Contributions)

- 121 Putting First Things First in Agronomy. F. J. Sievers. Jour. Amer. Soc. Agron. 24:29-32. January, 1932.
- 122 The Effect of Environment on the Nematode of the Tomato Gall. Linus H. Jones. Jour. Agr. Research 44:275-285. February 1, 1932.

- 125 An Ataxia of Chicks Associated with Nephritis. Glen L. Dunlap. Jour. Amer. Vet. Med. Assoc. 80 (N. S. 33): 880-885. June, 1932.
- 126 Acetic Acid and Pyroligneous Acid as Soil Disinfectants. William L. Doran. Jour. Agr. Research 44:571-578. April 1, 1932.
- 127 Stomatal Apparatus of the Cultivated Cranberry, *Vaccinium Macrocarpon*. Wm. H. Sawyer, Jr. Amer. Jour. Bot. 19:508-513. June, 1932.
- 128 A New Jelly-Strength Tester. C. R. Fellers and J. A. Clague. Indus. and Engin. Chem., Analyt. Ed. 4:106. January 15, 1932.
- 129 The Significance of Differences in Means in Repetition Experiments. F. A. Hays. Poul. Sci. 11:14-17. January, 1932.
- 130 A Three-Year Study of the Chemical Composition of Grass from Plots Fertilized and Grazed Intensively. J. G. Archibald, P. R. Nelson and E. Bennett. Jour. Agr. Research 45:627-640. November 15, 1932.
- 131 Susceptibility of Chickens to Brucelliasis. H. Van Roekel and others. Jour. Amer. Vet. Med. Assoc. 80 (N. S. 33): 641-642. April, 1932.
- 132 The Mineral Composition of Dates. M. M. Cleveland and C. R. Fellers. Indus. and Engin. Chem., Analyt. Ed. 4:267. July 15, 1932.
- 133 Rapid Centrifugal Method for Pectic Acid Determination. C. R. Fellers and C. C. Rice. Indus. and Engin. Chem., Analyt. Ed. 4:268. July 15, 1932.
- 134 The Influence of Temperature on the Nitrate Content of Soil in the Presence of Decomposing Cellulose. James E. Fuller and Linus H. Jones. Soil Sci. 34:337-350. November, 1932.
- 135 Early and Late Feathering in Rhode Island Reds. F. A. Hays. Amer. Nat. 66:286-287. May-June, 1932.
- 136 Public Health Aspects of Frozen Foods. Carl R. Fellers. Amer. Jour. Pub. Health 22:601-611. June, 1932.
- 137 Monograph of the Genus Pestalotia, Part II. E. F. Guba. Mycologia 24: 355-397. July-August, 1932.
- 139 Chronic Carriers of Infectious Laryngotracheitis. Charles S. Gibbs. Jour. Amer. Vet. Med. Assoc. 81: (N. S. 34): 651-654. November, 1932.
- 144 Vitamin C in Canned Citrus Products. Carl R. Fellers and Paul D. Isham. Jour. Home Econ. 24:827-832. September, 1932.
- 146 Recent Developments in Ice Cream Manufacture. M. J. Mack. Food Industries. August, 1932.

Other Contributions to Journals

(Unnumbered)

- A Demonstration of Basal Growth. C. J. Gilgut and Linus H. Jones. Both Gaz. 94:221. September, 1932.
- Twig Scab and Spray Injury. E. F. Guba. Mass. Fruit Growers' Assoc. Rpt. 38:149-153. 1932.
- Forcing Gladiolus with the Aid of Artificial Light. Linus H. Jones. N. E. Gladiolus Soc. Yearbook 1932:123.
- New Theories About Flower Pots. Linus H. Jones. Horticulture 10:50. February 1, 1932.
- Aeration of Soil in Plant Containers. Linus H. Jones. Florists' Exch. 79 (11):39. March 12, 1932.
- Why House Plants Die in Dry Modern Homes. Linus H. Jones. New York. Times. Sunday, Science, April 10, 1932:5.
- For More and Better Hyacinths in the Home. Linus H. Jones. Florists' Exch. 79 (18):9. April 30, 1932.

- Flower Pots for the Public. Linus H. Jones. Florists' Exch. 79 (25):29. June 18, 1932.
- Cement Flower Pots. Linus H. Jones. Florists' Exch. 80 (2):9. July 9, 1932.
- Summary of Orchard Pests in 1931. A. I. Bourne. Mass. Fruit Growers' Assoc. Rpt. 1932.
- Control Studies of Apple Maggot in 1931. A. I. Bourne and W. H. Thies. Mass. Fruit Growers' Assoc. Rpt. 1932.
- Spray Materials and the Residue Problem. O. C. Roberts and A. I. Bourne. Mass. Fruit Growers' Assoc. Rpt. 1932.
- Gladiolus Thrips. W. D. Whitcomb. N. E. Gladiolus Soc. Yearbook 1932.
- A Good Dusting Machine for Nurseries. W. D. Whitcomb. Natl. Nurseryman Vol. 40, No. 2, 1932.
- Relation of Temperature to the Activity of the Plum Curculio. W. D. Whitcomb. Mass. Fruit Growers' Assoc. Rpt. 1932.
- Study of Labor Saving Methods and Technique on Vegetable Farms in Massachusetts. R. H. Barrett. Jour. Farm Econ. Vol. 14, No. 2. April, 1932.
- To Account for the Variations in the Amount of Labor Used in Performing Hand Work on Vegetable Farms. R. L. Mighell. Soc. Sci. Research Council Bul. 13. June, 1932.
- Training Men for the Food Industries. C. R. Fellers. Refrigerated Food News 2 (10):1-4. June, 1932.
- Souring of Dates by Yeasts. C. R. Fellers and J. A. Clague. Jour. Bact. 23:63. January, 1932.
- And Now Comes Canned Rat Bait. E. M. Mills and C. R. Fellers. Canning Age 13:200, 220. March, 1932.
- Canned Cranberry Sauce. C. R. Fellers. Canner 75 (4):7-10. July 9, 1932.
- A Plan for the Eradication and Control of Infectious Laryngotracheitis. C. S. Gibbs. Poul. Sci. 11 (6): 360-361. November, 1932.

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MASSACHUSETTS:

↑ AGRICULTURAL EXPERIMENT STATION, *Amherst*

BULLETIN NO. 305

MARCH 1934

Annual Report

For the Fiscal Year Ending November 30, 1933

The main purpose of this report is to provide an opportunity for presenting in published form, recent results from experimentation in fields or on projects where progress has not been such as to justify the general and definite conclusions necessary to meet the requirements of bulletin or journal.

MASSACHUSETTS STATE COLLEGE
AMHERST, MASS.

[1934]

MASSACHUSETTS AGRICULTURAL EXPERIMENT STATION

Trustee Committee on Experiment Station

	Term Expires
PRESTON, CHARLES H., Hathorne, <i>Chairman</i>	1939
WHITMORE, PHILIP F., Sunderland.....	1934
RUSSELL, HOWARD S., Waltham.....	1936
FROST, HAROLD L., Arlington.....	1938
MALCOLM, DAVID J., Charlemont.....	1939
GILBERT, ARTHUR W., Belmont, <i>State Commissioner of Agriculture, ex officio</i>	

Experiment Station Staff, December 1933

HUGH P. BAKER, President of the College

SIEVERS, FRED J., Director

KENNEY, FRED C., Treasurer

LINDSEY, JOSEPH B., Vice-Director Emeritus

CHURCH, LUCIA G., Secretary

GASKILL, EDWIN F., Assistant to the Director

BEAUMONT, ARTHUR B., Agronomy	JONES, LINUS H., Botany
*BOURNE, ARTHUR I., Entomology	KIGHTLINGER, C. V., Tobacco-Disease Investigations
*BRADLEY, LEON A., Bacteriology	KUZMESKI, JOHN W., Fertilizer Law
*CANCE, ALEXANDER E., Agricultural Economics	McLAUGHLIN, FREDERICK A., Seed Law
§CIENOWETH, WALTER W., Horticultural Manufactures	*MIGHELL, RONALD L., Farm Management
DORAN, WILLIAM L., Botany	MUELLER, WILLIAM S., Dairy Industry
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FELLERS, CARL R., Horticultural Manufactures	SPELMAN, ALBERT F., Feed Law
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CONTENTS

Introduction.....	4
Department Reports:	
Agricultural Economics.....	5
Agricultural Engineering.....	6
Agronomy.....	7
Bacteriology.....	15
Botany.....	17
The Cranberry Station.....	22
Dairy Industry.....	25
Entomology.....	28
Farm Management.....	37
Feed Control Service.....	38
Fertilizer Control Service.....	39
Floriculture.....	41
Home Economics.....	42
Horticultural Manufactures.....	43
Olericulture.....	45
Plant and Animal Chemistry.....	48
Pomology.....	50
Poultry Husbandry.....	55
Veterinary Science.....	56
Waltham Field Station.....	59
Cooperative Investigations:	
Cranberry.....	24
Tobacco.....	14
Publications.....	63

ANNUAL REPORT OF THE MASSACHUSETTS AGRICULTURAL EXPERIMENT STATION — 1933

INTRODUCTION

F. J. Sievers, Director

In the field of research the merit of the product will always be directly proportionate to the ability of the investigator. For this reason, if no other, standardization should never be carried to a point where it interferes with the opportunity for the worker to express his individuality. With emphasis on this point, nothing can influence an experiment station organization quite as much as a change in personnel. During the last year this Station has seen pronounced changes in this respect.

On December 26, 1932, Dr. Joseph B. Lindsey, at the age of 70, was automatically retired from service through the operation of the retirement system for employees of the Commonwealth. He had been identified with the College for about forty years of continuous service in various capacities: as Assistant to Dr. Charles A. Goessmann, the first Professor of Chemistry at the College and the founder of the Experiment Station; as Research Professor in Animal Nutrition, a position held until his retirement; as Goessmann Professor and Head of the Department of Chemistry; and as Vice Director of the Experiment Station.

During this period he was not only a pioneer in the research related to animal nutrition, but also a very prominent factor in directing and formulating legislation which protected the farmer against adulterated feeds and fertilizers. His interest in most phases of education and his distinct common sense and practical approach to all problems, coupled with a strong and lovable personality, made him a delightful leader. Among agricultural scientists he is best known for his contributions in the field of animal nutrition, but his friends place a much greater value on his qualities of manhood.

A much more tragic change in the Experiment Station organization was experienced on December 5, 1933, through the sudden death at the age of 61 of Dr. Roscoe W. Thatcher. His record in the field of education is well known and since his death has been so thoroughly reviewed in scientific journals and local publications that it requires no consideration here further than to say that he had been given every honor that his associates had it in their power to bestow.

He accepted the presidency of Massachusetts State College in 1927 and served in that capacity until 1932, when he found it necessary to retire because of poor health. This decision made him free to accept appointment as Research Professor of Chemistry in the Experiment Station. After a leave of absence of several months, he actively and enthusiastically entered the field of research where every one hoped he would give many more years of valuable service. His sane viewpoint, conscientiousness in effort, and splendid training justified this expectation. His honesty and fairness combined with a frankness and sincerity all too uncommon made him beloved and respected by all with whom he made contact. He was not unwilling to confess his own faults and was so charitable to the faults of others that it was a pleasure to work with him. His leadership in education and especially in the organization and direction of research has made a lasting impression. His friendship and lovable character we shall never forget.

DEPARTMENT OF AGRICULTURAL ECONOMICS

Alexander E. Cance in Charge

Factors Affecting the Price of Eggs. (A. H. Lindsey.) Work on this project was suspended to allow for the completion of the bulletin on "Shipping Massachusetts Apples," in time for publication this fall.

Competitive Factors Influencing the Supply of Market Milk and Cream. (A. H. Lindsey and A. E. Cance.) The importance of the secondary markets to the dairymen of Massachusetts is illustrated by the fact that 81.6 per cent of the supply to 29 Massachusetts cities of over 10,000 people (outside of the Metropolitan milk shed) came from within the State. Vermont supplies 7.1 per cent; New Hampshire 5.3 per cent; Connecticut 1.9 per cent; Rhode Island 3 per cent; New York 1 per cent; and Maine 0.07 per cent. These out-of-state supplies total 41,667,305 quarts yearly. This may be compared with 65,420,000 quarts supplied to the Boston area by Massachusetts producers.

Data on the consumption of milk by 5,010 to 7,793 families in Worcester during the month of April for the years 1928, 1930 and 1932 were supplemented by data for 8,032 families for April 1933. Data for about 400 identical families for the same periods were also obtained. In summary the data show that the average regular daily deliveries of milk per family were:

Quarts	Year	Index
1.366	1928	100
1.351	1930	99
1.362	1932	99
1.317	1933	96

That is, regular deliveries in 1933 were about 96 per cent of those in 1928.

The data on the consumption by identical families are subject to slight error because of the disappearance in 1932 and 1933 of some of those selected in 1928. Using an index of 100 to represent average daily consumption in April 1928, the index rose to 101 in 1930 and then fell to 98 in 1932, and to 91 in 1933.

In general the data indicate a comparatively stable demand for milk despite lowered incomes and unemployment.

Marketing of Milk in Secondary Markets of Massachusetts. (David Rozman.) This study has been completed and published as Bulletin 304.

Decentralization of Industry and Part-Time Farming in Massachusetts. (David Rozman.) This project has been approved only recently, and the work is in its initial stages. The main objectives are to investigate and analyze the most important features connected with part-time farming made possible by the location of industrial plants in small towns and villages, and to indicate the type and condition of land settlement most suitable under varying conditions of working in the industrial plants established in the country.

Changing Methods of Wholesale Distribution of Perishables. (Lorian P. Jefferson.) The importance of this project increases as the emphasis continues to shift from one type of wholesaler to another. The traveling jobber becomes a greater factor in the system, a factor which disturbs not only the regular wholesaler and jobber but the railroads, which are affected by him as well as by the truck operator who does not hold title to the goods he carries. City and state throughout the country seek legislation looking to the control of both these

agencies. With these changes there is also some evidence of change in credit arrangements.

Shipping Massachusetts Apples. (A. H. Lindsey and A. A. Brown.) The report of this project is contained in Bulletin 299. Its publication proved very timely, for prices in the Boston market this year are much lower than prices in other large eastern markets, and consequently producers have found it profitable to ship to markets suggested in the bulletin.

DEPARTMENT OF AGRICULTURAL ENGINEERING

C. I. Gunness in Charge

Investigation of Apple Storages. (C. I. Gunness.) The study of the effect of humidity on evaporation from apples in cold storage has been continued, and results to date indicate that the humidity should not be allowed to fall below 80 per cent in order to prevent shriveling. The work on holding the apples at a temperature higher than 32° for the early part of the season has been continued, and results are reported by the Department of Pomology. No appreciable difference in humidity has been obtained from the use of wet and dry blowers in the one storage where both types are used under similar conditions.

Apple Handling Equipment. (C. I. Gunness.) A pivot tray type of elevator has been developed for handling apple boxes, and plans prepared for distribution. This type of elevator has proved very satisfactory, and particularly economical in floor space as compared with escalators.

A washer for the removal of spray residue on apples has just been completed for experimental work to be carried on in the Department of Pomology. The outstanding feature of this washer is that the acid tank is placed near the floor with the washing tank above it. Apples are moved by a spray from a circulating pump, and the apples are raised from the acid bath, taken through the wash bath, and delivered to the grader by means of a tray elevator.

Fertilizer Distributors. (C. I. Gunness.) The fertilizer attachment which was developed last year for a tobacco transplanter was further improved during the past season, particularly by providing stirring equipment in the hopper to prevent arching. The results obtained through the use of this attachment are reported by the Department of Agronomy.

Milk Cooling Equipment. (C. I. Gunness.) During the past year a device was developed for pre-cooling milk in 20- or 40- quart cans during the time of milking by directing a spray of water on to the outside of the can. It was found that milk can be pre-cooled to 70° with a reasonable amount of water with cooling water at 55° or less.

In order to overcome the difficulty of low water in milk cooling tanks where part of the milk is cooled in the evening and part in the morning, an arrangement was developed whereby a circulating pump forced a spray of water directly on to the neck of the can where the water did not come up to the level of the milk in the can. With this arrangement it was found that milk could be cooled from 90° to 50° in 45 minutes.

DEPARTMENT OF AGRONOMY

Walter S. Eisenmenger in Charge

Pasture Experiments. (A. B. Beaumont.) Results of experiments in the top-dressing of upland permanent pastures in Worcester County for three years (1930, 1931, 1932) have been summarized. A marked response to applied nitrogen, medium response to potash and lime, and a slight increase due to superphosphate are shown. A chemical study of the soils showed that they were deficient in readily "available" phosphorus but had a high fixing capacity for phosphoric acid.

Longevity of Alfalfa Stands. (A. B. Beaumont.) In 1927 ten varieties and strains of alfalfa were sown with differential fertilizer and lime applications. Marked differences were found in longevity of varieties and strains, but practically no differences which could be assigned to fertilizer or lime treatments. The experiment proved that varietal adaptation to climatic conditions was a much more important factor in the longevity of alfalfa than induced soil fertility conditions.

The first phase of the experiment was concluded in 1930, and the field was plowed and fallowed until the summer of 1931 when it was refertilized and reseeded with one variety of alfalfa (Grimm). Greater differences in amounts of applied fertilizer were made at this time than at the beginning of the experiment. Yields of the second cutting of the 1932 and 1933 crops were weighed and indicate a slight response to phosphoric acid and potash. The stand is still good on all plots except those which received no fertilizer. The experiment must be continued longer before conclusions can be drawn.

Legume Variety Tests. (M. C. Darnell and A. B. Beaumont, in cooperation with the Eastern States Farmers' Exchange and the Division of Forage Crops and Diseases, Bureau of Plant Industry, U. S. D. A.)

Alfalfa. The highest yielding varieties for 1933 were as follows:

1929 seeding (from second cutting only): Italian (1.82 tons); Utah (1.74 tons); Dakota, Kansas and New Mexico (1.71 tons).

1930 seeding (from two cuttings): South African (3.72 tons), Hungarian (3.70 tons), Italian (3.65 tons), Oklahoma (3.57 tons), and Hardigan (3.51 tons).

1931 seeding (from two cuttings): New Mexico 19010 (4.63 tons), Hardigan (4.56 tons), New Mexico 19011 (4.54 tons), Argentine (4.53 tons), and Utah (4.49 tons).

1932 seeding (from two cuttings): Cossack (3.26 tons); Hardigan (3.03 tons); New Mexico (2.96 tons); Grimm (2.80 tons); Ontario Variegated, Kansas, and Montana (2.77 tons).

No new alfalfa plots were seeded in 1933.

Red Clover. The data from two cuttings of red clover plots seeded in 1932 afford the same conclusions as in previous years—that the northern-grown American varieties are the best yielders. The highest yielder was Ohio (3.78 tons). No new plots were seeded in 1933.

Vetch. The results of the 1932 fall seeding of vetch and wheat were incorporated in a summary of vetch yields covering the duration of the experiments, 1930-1933. From the 1932 seeding, Oregon Hairy yielded .79 tons of vetch, followed by Smooth which yielded .69 tons. For the two years, the Smooth vetch averaged .70 tons, Oregon Hairy .69 tons. It was concluded that this

legume should not be permanently substituted as a forage crop for clovers, alfalfa, or soybeans.

Soybeans. Forty-nine new soybeans, including nine edible varieties, were observed in 8-foot rows, to determine their adaptability to New England conditions. Two of the edible varieties and seven of the forage varieties did not reach maturity.

Sweet Clover. Plots of hulled and unhulled sweet clover were seeded at intervals from December 1931 to May 1932, and their yields compared after cutting in 1933. The best yield (2.19 tons) was obtained from the February 1 seeding of unhulled. This is in general agreement with the results of the previous experiment.

Crimson Clover. The highest yields of crimson clover (.96 tons when grown with oats as a companion crop, 1.19 tons when grown alone) were obtained from plots seeded in the middle of May rather than later.

Lespedeza. Two strains of early Korean Lespedeza were seeded early in May, and the seed harvested in October. Strain 65280 yielded 72 pounds of seed per acre; strain 59379, 101 pounds per acre. A rather dense growth was observed on the volunteer reseeding from the shattered seed of the previous year's crop.

These two strains were also seeded on an upland pasture early in the spring before frost had come out of the ground. Seed were not worked into the soil by artificial means. The fields used had been previously used for a top-dressing fertilizer and lime experiment. There was a fair stand of lespedeza plants early in the spring before grazing had begun, but at the end of the season less than 1 per cent of lespedeza plants could be found in the sod. They were very small, but in most cases bore seed. Little or no difference in stand of lespedeza could be attributed to the differential fertilizer and lime treatments.

Top-Dressing Grasslands with Fertilizers. (A. B. Beaumont, R. W. Donaldson, and M. E. Snell.)

Fertilizer Ratios. Part I of this experiment was terminated at the close of the 1932 season, and the field plowed and reseeded in the summer of 1933. The general plan of the previous experiment was followed except that enough phosphoric acid (in the form of 16 per cent superphosphate) to last for about 5 years was applied and harrowed in prior to seeding. Nitrogen and potash will be applied annually as top-dressing. Part II was started in 1932, and differs from Part I only in that wider ratios were used. The yields are summarized below:

Mean Yields of Cured Hay

Part I, 5 years (1928-1932)			Part II, 2 years (1932-1933)		
Fertilizer Ratio	Pounds per Acre	Rank	Fertilizer Ratio	Pounds per Acre	Rank
6:3:3	5171	1	8:3:3	4785	1
4:3:3	4533	8	4:3:3	4002	7
2:3:3	3985	9	0:3:3	2778	9
3:6:3	4811	5	3:8:3	4320	4
3:4:3	4691	6	3:4:3	4055	6
3:2:3	4831	4	3:0:3	4107	5
3:3:6	5162	2	3:3:8	4565	2
3:3:4	4858	3	3:3:4	4433	3
3:3:2	4571	7	3:3:0	3544	8

It may be noted that a distinct response to nitrogen and potash, but no response to phosphoric acid, all as top-dressing, is indicated by these figures.

Forms of Nitrogen. This experiment in the top-dressing of an old mowing was started in 1932. Cyanamid came from last place last year to first place this year in the order of effectiveness. The relative yields from the various treatments for 1933 are as follows:

Check (no nitrogen).....	100
Ammonium Sulfate.....	192
Urea.....	193
Nitrate of Soda.....	216
Cyanamid.....	220

This field has received no phosphatic or potassic fertilizers and no lime since the experiment began.

Experiments with the Newer Nitrogen Fertilizers. (A. B. Beaumont.) In the spring of 1929 a field experiment was started with several of the new nitrogen fertilizers, some of the old standard carriers being used for comparison. The materials used were:

	Per cent N	Per cent P_2O_5
Ammonium Sulfate (by-product).....	20.5	
Ammonium Phosphate (Ammono-Phos)....	11	48
Diammonium Phosphate (Di-ammonphos)	21	53.4
Ammonium Chloride.....	26.2	
Calcium Nitrate.....	15.5	
Nitrate of Soda (Chilean).....	15.5	
Nitrate of Soda (synthetic).....	16.25	
Urea.....	46	
Calcium Cyanamid.....	22	

For the first two years of the experiment, the fertilizer used on all plots was equivalent to 800 pounds of a mixture containing 4 per cent N, 17.45 per cent P_2O_5 , and 6 per cent K_2O . No fertilizer was applied the third year when hay was grown. The fourth and fifth years the fertilizer was equivalent to 1200 pounds of the mixture indicated. The reaction of the soil used was about pH 6.2 at the beginning of the experiment. Four crops of ear corn and one crop of mixed grass and clover hay have been grown in the period 1929-1933. No significant differences in yield have been obtained from the different fertilizers, although the yield from ammonium sulfate is trending low. This material and ammonium chloride have slightly lowered the pH value of the soil. The nitrates and calcium cyanamid, particularly the latter, have somewhat raised the pH value. The two ammonium phosphates and urea have not effected marked differences in the soil reaction.

This experiment indicates that on a soil of this character one may expect almost identical results from the nitrogen fertilizers used for tilled crops having requirements similar to those of corn for a period of five years at least, without the use of lime. If the experiment is to be continued on the same plan, further divergence in soil conditions resulting from the use of the different nitrogen fertilizers, and corresponding variations in yield of crops may be expected.

Field Experiments with Tobacco. (A. B. Beaumont and M. E. Snell.)

Cropping Systems. Results for the period 1924-1932 were summarized in the last annual report and have since been published in Bulletin 297.

In 1933 changes were made in the plan of the experiment which involved the lengthening of the tobacco rotation and the substitution of new cover crops for some which had been tried several years. As no lime had been applied to the field since the beginning of the experiment, and the reaction of the soil had been reduced to a fairly low point (about pH 5.0), all plots except five of the check plots were given an application of limestone at the rate of 1 ton per acre in the spring of 1933. (It should be understood that the differential treatments listed were supplementary to fertilizer which was applied to all plots alike.) Yields from the various treatments were:

	Pounds per Acre
Check plots without lime.....	1894
Check plots with lime.....	1809
Manure supplement.....	2017
Manure and red top cover crop.....	1747
Oats cover crop.....	1742
Barley cover crop.....	1557
Spring wheat cover crop (sown in the fall).....	1545
Clover cover crop.....	1766

Form Of Nitrogen. In the experiment with fertilizers having one half of the nitrogen from cottonseed meal and the other half from different carriers, the highest yield was obtained from the mixture containing calcium cyanamid, closely followed by the standard mixture (containing a mixture of different nitrogenous materials), urea, nitrate of soda, and ammonium sulfate.

Quantity of Organic Nitrogen. In the experiment with different proportions of organic and inorganic nitrogen, the highest yield was obtained from the mixture containing $3/8$ organic nitrogen and $5/8$ inorganic nitrogen, while that containing $1/4$ organic nitrogen gave the lowest yield. Tobacco grown in this experiment in 1932 showed little difference in grade index when sorted.

Method of Applying Fertilizer to Tobacco. This experiment was continued in 1933 with the same methods and equipment that were used the previous year. The average yields were as follows:

Machine Application		Broadcast Application (Check)	
	Pounds per Acre		Pounds per Acre
$4/8$ Standard application	1782	Standard application	1900
$5/8$ Standard application	1778	Standard application	1801
$6/8$ Standard application	1885	Standard application	1852

The experiment was repeated on one of the nearby private farms used in 1932. The highest yield was obtained with the $6/8$ standard application alongside the row.

Four years' results from this experiment indicate that the amount of fertilizer may be reduced $1/4$ to $3/8$ without reducing yield or impairing grading quality of tobacco, if the fertilizer is applied near the row instead of broadcast. In addition, the operations of broadcasting and harrowing in fertilizer are saved.

Magnesium Requirement of Crops. (A. B. Beaumont and M. E. Snell.) The soil on which this experiment is being conducted is only moderately deficient in magnesium, judging from reports of experiments on magnesium-deficient soils in other sections. Within recent years 14 common crop plants have been grown in this experiment, but only 5—corn, tobacco, oats, buckwheat, and turnips—have shown definite symptoms of magnesium deficiency, and the yield of some of these was not seriously reduced. Buckwheat is one of the most sensitive to magnesium deficiency of the plants studied in this experiment. Certain weeds have shown marked symptoms of magnesium deficiency. The crops grown in 1933 were barley, oats, Sudan grass, Japanese millet, buckwheat, turnips, and corn. With the hope of accentuating soil differences of the field under experiment, an acid-producing fertilizer was used this year, and another application of lime was given the portion previously limed.

Methods for Determining Magnesium Deficiency in Soils. (J. L. Haddock.) Various laboratory methods for the determination of mineral deficiencies in soils were studied during 1931-32. Two of these methods showed fair agreement with pot and field tests. The Newbauer method may be used on soils very deficient or well supplied in magnesium. The exchangeable magnesium as obtained by soil extraction with normal KCl solution gave close agreement with magnesium-deficient soils, as shown by chlorosis of corn and tobacco.

An interesting observation was made in the summer of 1932 on the magnesium plots. It was noted that the common weed, lamb's quarters (*Chenopodium album* L.), was growing on all plots along with buckwheat. On the plots treated with magnesium the weeds grew to an average height of 3 feet, while on the deficient plots there were fewer weeds and the plants had an average height of only 15 inches.

Chemical analysis of corn and lamb's quarters grown on the magnesium plots gave some interesting results which suggest that this weed may be useful as a magnesium indicator plant.

Chemical Content of Corn and Lamb's Quarters as Influenced by Soil Treatment

Treatment	Content of Corn Stover Per Cent		Content of Lamb's Quarters Per Cent	
	Ca	Mg	Ca	Mg
Calcium alone.	0.49	0.12	2.39	0.16
Calcium + magnesium.	0.39	0.15	1.98	0.44
Magnesium alone.	0.38	0.18	1.40	0.48
No calcium; no magnesium.	0.41	0.08	1.67	0.12

Onion Field Experiments. (M. E. Snell.)

Onion Set Production. The past season's work on this project has but confirmed the statements made in the last annual report regarding fertilization for onion set production. The yields of sets were somewhat lower in 1933, and there was a tendency for the smaller sizes to be slightly more numerous. Since the use of 500 pounds of the 2-12-8 fertilizer was so successful last year, 1000 pounds were tried this year, but no improvement was seen. In previous tests all rows have been 13.8 inches apart, but the past season they were tried 8 and 11 inches apart. It was rather difficult to operate between rows only 8 inches apart, and the yield was not increased with the 500 pounds of 2-12-8 fertilizer used. Perhaps 1000 pounds of this fertilizer would have been better in this case.

The 11-inch rows, however, gave very good results with the same fertilizer application.

The sets produced in 1932 were graded and weighed for storage loss after they had been stored for about six months. The loss included sprouting, decay, and shrinkage from loss of moisture. On the $\frac{1}{2}$ - $\frac{3}{4}$ inch sizes, the loss was 28 per cent with the sets grown on the 0-12-8 fertilizer as compared with about 15 per cent on the other fertilizer treatments. The losses of the sets grown with 500 pounds of the 4-12-8 fertilizer were as follows:

Size of Set	Loss Per Cent
$\frac{1}{4}$ - $\frac{1}{2}$ inch	20
$\frac{1}{2}$ - $\frac{3}{4}$ inch	16
Over $\frac{3}{4}$ inch	13

Since the ultimate value of onion sets is for the production of onions, a test was made to determine the influence of the fertilizer treatment used in growing the sets on the yield of plants grown from these sets and their tendency to develop seed stalks and multiple bulbs. The sets grown in these tests were also compared with commercially grown sets. Both of the two larger sizes were planted because the smaller size would not give information on seed stalk production. The large size, $\frac{3}{4}$ -1 inch, gave a considerably higher total yield, but after the removal of all bulbs which developed seed stalks or multiple bulbs, the difference was very slight. With the small size sets, multiple bulbs were negligible in all cases, and less than 1 per cent had seed stalks except for the commercial which had 3.8 per cent. The large size, $\frac{3}{4}$ -1 inch, gave the following results:

Sets	Fertilizer Used to Grow Sets	Percentage with Seed Stalks	Percentage with Multiple Bulbs
$\frac{3}{4}$ -1 inch	0-12-8	15.7	3.1
	2-12-8	18.2	3.6
	4-12-8 (500 lbs.)	18.7	2.1
	4-12-8 (1000 lbs.)	28.3	8.5
Commercial sets		37.9	17.7

This seems to indicate not only that good yields of the desired size of set can be produced locally, but that they compare very favorably with commercial sets for keeping quality and production of onions. It must be remembered, however, that this test is only for one year, and the results may not be conclusive.

Onion Transplants. During 1933 another attempt was made to study the possibilities of growing onions from transplants instead of from seed or sets. This phase of onion growing is being considered because of the difficulty of growing good crops of seed onions and the expense of planting set onions, as well as the possibility of growing some of the larger, milder types of onions in this section.

It takes about three months in a greenhouse to grow plants for transplanting, and the labor of transplanting is about the same as it is with sets; so the expense of planting is pretty high.

In the trials made, seed onions which were planted at the same time as the transplants were not at all promising, but very fair results were obtained with the transplants of some of the varieties. Transplants would generally yield less than sets and would be later maturing, but very good yields of high grade onions can be obtained by this method.

Onion Breeding. (M. E. Snell.) The past season some of the better yielding inbred strains were planted on fair-sized plots for comparison with some of the better commercial varieties grown locally. Since the season was very unfavorable for seed onion production, the yields were very small and poor in all cases, but the commercial varieties were generally superior to the inbred strains.

For the first time bulbs selected from first-generation hybrids were planted for seed production. Many of the bulbs showed good vigor as compared with the inbred strains. Sets had also been grown from inbred strains and were planted for bulb production. The growing plants from the sets were remarkably uniform in type and in most cases had some outstanding characteristics. This phase of the breeding work should not be overlooked, as it appears that the principal way in which onions are to be grown in this section is from sets. Sets also offer much more satisfactory material for this work than seed onions which often give very unsatisfactory yields necessitating the use of undersized and poor bulbs for seed production. With sets there is, of course, the difficulty of growing good sets for planting from only a small amount of seed.

The past season the bulbs for crossing were grown in the station glasshouse on cars which could be pushed in or out as desired. This permitted the pollination of flowers in wet weather as well as fair, and a much better set of seed was obtained than previously.

Toxicity of Aluminum for Tobacco. (Walter S. Eisenmenger.) Tobacco plants were grown in aluminum citrate solutions. These plants grew in a complete nutrient solution for two days, and on the succeeding two days the phosphates were withheld and various concentrations of the aluminum salt were added—0, 2, 5, 15, 30, 50, 70, 85, 95, 98, and 100 per cent of 0.006 M. Toxicity was indicated in dry weight of tops and roots.

At present the antagonistic effect of the calcium ion on the aluminum ion in the nutrient solution is being determined.

The Toxicity of Aluminum for Seedlings, and the Action of Certain Ions in the Elimination of the Toxic Effects. (Walter S. Eisenmenger.) Seedlings of corn, soybeans, and buckwheat were grown in various concentrations of aluminum citrate and aluminum tartrate. The concentrations were 2, 5, 15, 30, 50, 70, 85, 95, 98, and 100 per cent of 0.006 M of the aluminum salt. Fifty seedlings were used for each concentration, 50 were grown in distilled water, and 200 were grown in a complete nutrient solution. The comparison of those grown in a complete nutrient solution with those grown in the aluminum salt solution indicated that the toxicity of the salts increased with increased concentration, but the degree of toxicity was much less pronounced above 30 per cent of 0.006 M.

Both the hydroxyl and the calcium ions were factors in overcoming the toxicity of the aluminum salts. By adjusting the pH of the nutrient solution with citric acid to make it comparable to the pH of the aluminum salt solutions, it was found that the aluminum ion was more of a factor in growth retardation than the hydrogen ion in aluminum salt solutions.

Distribution of Nitrogen in Infusions of Plants. (Walter S. Eisenmenger.) Water infusions of different plants were made in the greenhouse, the plants being kept in the crocks of water for seven weeks. The water or colloidal solution was then filtered off and analyzed for different forms of nitrogen. Except for one corn stover which was simply ground up after it had been kept for one year in a barn, the plants comprised the mature plants including roots and tops, and were timothy, red clover, red top, tobacco, and corn. The latter consisted of the

stalks and roots when the plant was ready to cut. The rate of decomposition was about the same for corn, timothy and red clover. The tobacco decomposed most readily, and the red top least of all.

The nitrogen of tobacco in the filtrate was for the most part protein and ammonia nitrogen, and the red top content resembled the tobacco in this respect to a degree. Corn, timothy, and clover contained, in addition to ammonia and protein, appreciable amino acids, amide, and humus nitrogen.

There was an analogy between those plants causing brown root-rot of tobacco and the N content of the infusions.

Fine Turf Grasses. (L. S. Dickinson.) Further extensive studies are being made concerning the need of pre-seeding fertilization of turf areas. These experiments are being conducted on typical fine turf soil, and turf is growing under natural conditions. The results confirm those obtained in 1931 and 1932 and indicate that on normal soils a single phosphorus carrier is all the pre-seeding fertilizer necessary or desirable for fine turf grasses.

A cooperative experiment has been conducted to compare the value, to turf growers, of American peats and leaf molds with that of foreign peats, when mixed with various types of soil. The results obtained show no evidence in favor of foreign peats.

Through the sponsorship of Merck and Company, chemists, studies have been made of the value of the fungicide, Laboratory Number R. T.-50, for the control of certain fungous diseases of turf grasses. This fungicide was found to compare very favorably in effectiveness with the mercury fungicides commonly used, and the fact that it is neither poisonous, corrosive, nor caustic is a distinct advantage.

COOPERATIVE TOBACCO INVESTIGATIONS

Conducted by the Bureau of Plant Industry, United States Department of Agriculture, in Cooperation with the Massachusetts Agricultural Experiment Station.
C. V. Kightlinger, U. S. D. A., in Charge.

Black Root-Rot. (C. V. Kightlinger.) In continued investigation, numerous strains of Havana Seed tobacco were grown in the field during 1932 (the third year of the investigation), in the attempt to find strains of Havana Seed which may be satisfactory under Connecticut Valley conditions, for resistance to black root-rot, type of plant, type and quality of leaf, and producing capacity.

One strain was Havana Seed of the sort that is grown commonly in the Connecticut Valley, which is known to be susceptible to black root-rot, but is acceptable for type of plant and type and quality of leaf produced. This strain was used as a standard of comparison for type. One strain was Havana Seed 142A3, which is known to be satisfactorily resistant to black root-rot. This strain was used as a standard of comparison for such resistance. Of the new black root-rot resistant strains of Havana Seed tested in 1932, six were grown for the first time in 1930, seven for the first time in 1931, and eight for the first time in 1932. In one case these strains were all grown on land which was free or nearly free of *Thielavia basicola*, the fungus which causes black root-rot of tobacco. In another case the strains were all grown on land which was heavily infested with this fungus. Eleven of the new strains were selected for further testing in 1933.

The production of these eleven resistant strains and their checks, in 1932, was as follows:

Strain of Havana Seed Tobacco	Grown on land free or nearly free of <i>Thielavia basicola</i>			Grown on land heavily infested with <i>Thielavia basicola</i>		
	Yields per Acre Pounds	Grade Index	Crop Index	Yields per Acre Pounds	Grade Index	Crop Index
Common strain	2098	.419	879	1268	.256	325
142A3	2367	.440	1042	1991	.349	695
New strains {	No. 10	2612	.442	1153	.373	778
	No. 13	2312	.480	1110	.380	806
	No. 27	2437	.426	1038	.370	704
	No. 22	2400	.432	1036	.434	842
	No. 25	2377	.432	1027	.383	815
	No. 23	2390	.429	1025	.363	741
	No. 18	2338	.423	989	.373	663
	No. 14	2336	.415	969	.393	853
	No. 21	2378	.415	963	.380	738
	No. 15	2342	.406	948	.367	765
	No. 17	2212	.425	939	.395	719

NOTE: Grade Index is a number expressing the grading quality of tobacco produced by a strain in an experiment. It is based upon the percentage yield of grades, and the percentage relationships of these different grades, as given below:

Light wrappers	1.00	Long darks (19" & longer)	.30
Medium wrappers	.60	Dark stemming (17" & shorter)	.20
Long seconds (19" & longer)	.60	Fillers	.10
Short Seconds (17" & shorter)	.30	Brokes	.10

Grade Index is derived by multiplying the percentage yield of each grade by its respective percentage relationship in the above schedule and adding the products.

Crop Index is a number expressing crop value. It is derived by multiplying the total acre production of tobacco in pounds by the Grade Index value of that particular lot of tobacco.

Grade Index, Crop Index, and the adopted price relationships given above do not necessarily represent commercial values and prices.

Some of these resistant strains deserve testing on a considerably greater scale in numerous places in the Connecticut Valley, to determine their excellence in practical production. One strain was so tested in 1933 and proved to be highly satisfactory that season. Arrangements have been made for such testing of several of these strains in 1934.

DEPARTMENT OF BACTERIOLOGY

Leon A. Bradley in Charge

Application of the Azotobacter Soil Plaque Test for Determining Mineral Deficiencies in Massachusetts Soils. (J. E. Fuller.) Further studies have been made on plots previously investigated, and several new plots have been added. In all instances the Azotobacter test indicated a deficiency of available phosphorus even though satisfactory crops were grown on all of the plots represented. The results obtained from the tests agreed with those reported by several other investigators, and with those previously reported from this Station (Bulletin 293, p. 14). Tests by Truog's method indicated that the soils studied, with few exceptions, contained sufficient available phosphorus for crop growth. Perhaps some factor in the technique of the Azotobacter test may have been responsible for rendering the phosphorus in the soil unavailable for Azotobacter

growth. In testing acid soils, such as those of this vicinity, it is customary to add an excess of calcium carbonate to the soil to provide a reaction satisfactory for *Azotobacter* growth. Perhaps the calcium may combine with the phosphorus of the soil to form insoluble tricalcic phosphate which would not support *Azotobacter* growth. This possibility is being investigated.

Calcium Metabolism of Nitrogen-Fixing Bacteria. (J. E. Fuller.) This is a new project begun in the spring of 1933. The object is to determine whether calcium salts are important in the metabolism of bacteria except as regulators of reaction in the substrata. At present the study is limited to a consideration of the metabolism of *Azotobacter*. A medium free from calcium has been devised which produces more fixed nitrogen in *Azotobacter* cultures than is obtained on Ashby's Medium. Suitable reaction in the medium is obtained by the use of di-potassium phosphate. The addition of calcium carbonate in several concentrations has not resulted in greater quantities of nitrogen being fixed by *Azotobacter* cultures than when the calcium-free medium is employed. Care has been taken, by the use of analyzed chemicals, to obtain a medium which is free from all calcium except that which is purposely added.

Biological Studies of Bacteria of the Coli-Aerogenes Group. (J. E. Fuller.) This is another new project, the purpose of which is to investigate the physiology of, and the influence of environment on, members of the Coli-Aerogenes group of bacteria in the effort to interpret more satisfactorily the results of bacteriological examinations of water and milk. It is proposed to determine, if possible, whether bacteria of this group having different physiological reactions are in reality different species, or merely temporary variants produced by environment. The study has just been started and the time to date has been spent in the collection and purification of cultures.

Laboratory Service. (R. L. France.) Following is a list of the number and types of examinations made in the laboratory during the past year:

Milk (bacteria counts).....	1,087
Water.....	120
Miscellaneous:	
Butterfat.....	309
Solids.....	18
Stringiness.....	1
Total.....	1,535

The total number of analyses shows a slight increase over the previous year. The milk phase of service is proving of great value to producers, dairymen and local inspectors throughout the Valley.

The number of water analyses compares favorably with the previous year. Through the cooperation of the Engineering Specialist of the Extension Service, it will be possible in the future to make a sanitary survey of polluted private water supplies. By this means constructive suggestions as to the elimination of the pollution will be available, thus giving a most complete service in this field.

The stock of legume cultures has been kept intact and furnished to farmers requesting them for inoculation of leguminous plants.

The Indol Tolerance of the Coli-Aerogenes Group of Bacteria as a Possible Means of Differentiating Fecal and Non-Fecal Strains Occurring in Drinking Water Supplies. (R. L. France.) Results to date indicate a very definite

indol tolerance of certain fecal strains of *Bact. coli*. Information is now being accumulated on the indol tolerance of certain strains of *Bact. aerogenes* and the intermediate group.

A Comparison of Devereux "Yeast Extract" Agar and Standard Agar for Plating Milk Samples. (R. L. France.) A preliminary paper on this subject was read before the Connecticut Valley Section of the American Society of Bacteriologists. The results indicate that the "Yeast Extract" agar has no advantages over the Standard agar when used for determining the bacterial content of raw milk. Further data are being collected to determine the value of the Devereux agar when used for plating pasteurized milk. Studies are being made of several other media which might be used for determining the bacterial content of pasteurized milk. In these studies an incubation temperature of 32° C. is being used in addition to the standard temperature of 37° C.

The Effect of Aging Temperature on the Bacterial Count of Pasteurized Ice Cream Mixes. (W. S. Mueller and R. L. France.) The results of this investigation indicate that ice cream mixes may be held at 68° F. for six hours without any significant increase in bacterial count.

DEPARTMENT OF BOTANY

A. Vincent Osmun in Charge

Black Root-Rot of Tobacco. (W. L. Doran.) In 1932, tobacco was grown for the ninth year in a field last limed in 1923. Its burn this year was unaffected by the earlier liming. It was not of inferior quality, but had shorter leaves than tobacco from unlimed plots.

Tobacco plants in pot experiments were uninjured by ammonium sulfocyanate 800 pounds per acre, applied to soil 11 weeks before planting, but infection by *Thielavia basicola* was not prevented.

Aluminum phosphate 2 tons per acre, applied to soil in pot experiments, did not prevent black root-rot and did not affect growth of tobacco.

Brown Root-Rot of Tobacco. (W. L. Doran.) Growth of tobacco in brown root-rot soil was improved by applications of calcium nitrate and orthophosphoric acid together, but not by either alone. Sucrose 600 pounds per acre, applied to soil free from brown root-rot, did not induce the disease. Copper sulfate 120 pounds per acre had no effect on brown root-rot.

Downy Mildews of Cucumber and Lettuce. (W. L. Doran.) Downy mildew was severe on greenhouse cucumbers in the fall of 1932, but the fungus (*Peronosplasmopara cubensis* (B. & C.) Clint.) did not live on plants in greenhouses after early January. It was next found here in the field on September 2, 1933, the latest recorded date of its first appearance. Many fields escaped it until September 8, when picking was already over.

Soil in which cucumbers were growing (in crocks) was watered only with solutions of copper sulfate (0.29, 0.43, 0.57, 0.86, or 1.0 gram per gallon), applied often enough to keep the soil at or near the optimum moisture content for growth, beginning June 30 (when plants were 10 days old) and ending September 11. Plants were inoculated with *P. cubensis* on September 3. None of these treatments increased resistance to infection by this fungus, and all of them were slightly injurious to the growth of plants.

Soil, 3 inches deep in flats, in which lettuce seedlings were growing, was watered only with solutions of copper sulfate (0.43, 0.57, 0.86, and 1.0 gram per gallon), applied often enough to keep the soil at or near the optimum moisture content for growth. One month after treatment began, tip burn was severe on plants in soil receiving only water, but there was no tip burn on plants watered with any of the solutions of copper sulfate. At this time all plants were inoculated with *Bremia lactucae* E. Regel. Less infection (than the checks) resulted on plants in soil which had received copper sulfate, but plants were injured by the treatment. There was but little infection on plants in soil watered with 1.0 per cent copper sulfate solution, but this treatment was very injurious to plants.

Lettuce plants which had been watered for one month with these solutions of copper sulfate were set in the field, after which they received no more copper. They, too, were inoculated with *B. lactucae*, and the spread of downy mildew on them during the summer showed that no lasting protection had resulted from earlier applications of copper sulfate to the soil.

The following materials (per acre) were applied to soil in pots: potassium carbonate 1000 pounds, hydrated lime $3\frac{1}{2}$ tons, these materials together in these amounts, and copper sulfate 250 and 400 pounds. Lettuce plants were set immediately thereafter. These plants and untreated checks were inoculated with *B. lactucae* 4 weeks later. None of the treatments significantly affected infection. Great injury to the plants was caused by 400 pounds of copper sulfate and by potassium carbonate and hydrated lime applied together.

Control of Greenhouse Vegetable Diseases. (E. F. Guba, Waltham.) The probability of developing varieties of tomatoes sufficiently resistant to tomato leaf mold, caused by the fungus *Cladosporium fulvum* Cke., to prevent crop loss appears promising. Selections have been made of the F_1 and F_2 generations of the hybrids noted in the previous annual report (Bulletin 293, p. 17). The red currant tomato, *Lycopersicon pimpinellifolium* Mill., which is immune to the disease, has been hybridized with Success, Belmont and Break o' Day. Of several tomato hybrids grown in the field, the following showed the highest degree of resistance in the F_2 generation: Bewley II (Stonnor's M. P. X Up-to-Date) with Norduke, Bewley IV (E S 1 X Up-to-Date) with Norduke, Bewley I (Riverside X Up-to-Date) with Norduke, Norduke with Stirling Castle, Up-to-Date with Norduke, and Maincrop with Norduke. The parents of these hybrids possess considerable resistance to the disease, but they are not satisfactory greenhouse tomatoes. Other hybrids with a susceptible and a resistant parent showed no resistance in the F_1 growing.

A spray consisting of 1 ounce of salicylanilide paste (Shirlan H B) and $2\frac{1}{2}$ ounces of sulfonated oil spreader (Agral I), which is reported from England to be very effective in controlling the disease, was used with very good results. Spraying lacks the advantages of sulfur vaporization (see Bulletin 248). A patented sulfur vaporizing apparatus, the "Sulphurator," was investigated and subjected to certain improvements in construction. This ingenious apparatus gives promise of replacing other methods of applying sulfur fungicides under glass.

Eradication of Nematodes in Greenhouse Soils by the Use of Chemicals. (L. H. Jones.) Orthodichlorobenzene has not proved to be a practical substitute for paradichlorobenzene when used with calcium cyanide for the eradication of nematodes in ground beds. The poisonous effect on the plants persists longer and, although more than half the tomato plants were free of nematode galls, there was a greater degree of infection with orthodichlorobenzene than with paradichlorobenzene.

Vegetable Seed Treatments. (E. F. Guba, Waltham.) Organic mercury and red oxide of copper powders consistently gave the best results in controlling damping-off in the greenhouse, and the difference in the merit of the two materials was in general in favor of red copper oxide. Monohydrated copper sulfate in general gave comparatively poor results, but even these were better than with no treatments. In other experiments, dry powdered basic copper sulfates, copper acetates, and copper carbonates gave excellent results. In two extensive field experiments the best stand and growth were obtained from seed treatments with organic mercury and red oxide of copper, while monohydrated copper sulfate proved of little or no value. Further comparative tests of the most promising powders are planned, to determine the best dry seed treatment for each field-sown vegetable crop.

Injury was noted from soaking seeds of tomato, squash, cabbage, and cauliflower in mercuric bichloride solution at recommended intervals and dilutions, while corn and cucumber were not affected. Organic mercury soaks were safe. In view of the excellent stands resulting from seedbed treatments with oxy-methylene dusts under glass, and from dry seed treatments in the field, the practice of soaking seeds in liquid mercury disinfectants as an additional means of controlling certain crop diseases in the field is open to question.

Causes and Control of Decay of Winter Squash in Storage. (E. F. Guba, Waltham.) So far, work has been concerned with visitations to squash storages and the culturing of material for study. The following organisms have been isolated from decayed squash: *Rhizopus* sp., *Penicillium* sp., *Acrostalagmus cinnabarinus* Cda., *Hormodendron cladosporioides* E. & H., *Mycosphaerella citrullina* (C. O. Smith) Gross, two undetermined species of *Gloeosporium*, two undetermined species of bacteria, three undetermined species of *Fusarium*, and *Bacillus tracheiphilus* E. F. S. The biology of most of these species has been established and the different types of decay resulting from artificial inoculation described.

Complete surface disinfection of Blue Hubbard squash at a temperature range of 60° to 70° F. required 9 liquid ounces of formaldehyde and 6 ounces of potassium permanganate by weight to 1500 cubic feet of space, when the gas was confined 24 hours. Shorter exposures were ineffective, and the merit of weaker doses at longer exposures was not determined.

Strawberry Gold Leaf. (E. F. Guba, Waltham.) The seriousness of this non-infectious chlorotic disease of the strawberry is expressed in inferior plant making and increased susceptibility to winter injury—both of which greatly diminish the yield and quality of berries. Two comparative plots with the same number of mother plants had a difference in yield of 4349 boxes of berries per acre in favor of yellows-free stock. No spread occurred from diseased to healthy rows of plants growing adjacent to each other in the field. Propagation of these plants is being continued for further evidence. Vertical unions of the root crown of diseased and disease-free stock did not result in spread of the disease to the healthy half, or to its daughter plants in the first cropping season.

Diseases of Herbaceous Ornamental Plants Caused by Soil-Infesting Fungi. (W. L. Doran.) This project was begun with work on the effect of certain soil treatments on damping-off and on growth of plants. Except as otherwise indicated, treatments were applied to soil immediately before seeding. The number of grams of material applied per square foot of soil surface and thoroughly mixed with soil is indicated. Soil was 3 inches deep in flats. Most of the damp-

ing-off which occurred was caused by species of *Pythium*, although *Rhizoctonia* was also present in some instances.

Results of some of the experiments are tabulated below. The work to date is, of course, only preliminary, and the results should be considered as indicative rather than final.

Material Tested	Grams per Square Foot of Soil Surface	Effect on Damping-off	Effect on Plants
Aluminum sulfate	20	Not controlled	Harmless to all species used.
	25	Not controlled	Some injury to foxglove (<i>Digitalis purpurea</i>), aster (<i>Callistephus chinensis</i>), and beet.
	30	Not controlled	Injurious to <i>Primula polyantha</i> and cucumber; harmless to <i>Calendula officinalis</i> , sweet pea, and lupine (<i>Lupinus polyphyllus</i>).
	40	Less than check	Somewhat toxic to all species used except <i>Dianthus</i> .
Ammonium hydroxide (1) (sp. gr. 0.9)	1:60*	Not controlled	Harmless to all species used.
	1:50*	Fair control	Harmless to all species used.
	1:40*	Good control	Some injury to <i>Alyssum saxatile</i> and sweet alyssum (<i>Lobularia maritima</i>).
	1:30*	Good control	Toxic to <i>Alyssum saxatile</i> , sweet alyssum, sweet pea, <i>Scabiosa atropurpurea</i> , beet and cucumber.
Ammonium sulfocyanate (1)	3	Not controlled	Harmless to all species used.
	5	Not controlled	Harmless to sweet alyssum, <i>Calendula</i> , and beet; slight injury to cucumber.
	6	Not controlled	Harmless to sweet pea and <i>Calendula</i> ; injurious to cucumber and sweet alyssum.
Calcium acetate	20	Not controlled	Harmless or somewhat beneficial to <i>Delphinium</i> , hollyhock, mignonette, <i>Salpiglossis</i> , sweet pea, heliotrope, and petunia.
	40	Not controlled	
	50	Less than check	
Calcium cyanamide (1)	10	Good control	Benefited <i>Salpiglossis</i> and <i>Campanula medium</i> ; harmless to <i>Calendula</i> , sweet pea, and sweet alyssum.
	14	Good control	Harmless to <i>Alyssum rostratum</i> , beet, and cucumber; toxic to <i>Scabiosa</i> .
Calcium hypochlorite (1)	4	Not controlled	Toxic to <i>Centaurea imperialis</i> , sweet alyssum, and beet.
	8	Not controlled	Harmless to sweet pea.
	12	Less than check	Toxic to sweet pea, <i>Anchusa azurea</i> , <i>Lilium regale</i> , and nasturtium (<i>Tropaeolum majus</i>).
	16	Less than check	Very toxic to foxglove and common heliotrope; slightly toxic to stocks (<i>Matthiola incana</i> var. <i>annua</i>).
Copper, metallic (a powder, 99.8% metallic copper)	8	Less than check	Toxic to sweet pea, <i>Calendula</i> , beet, and cucumber.
	10	Less than check	Toxic also to mignonette, foxglove, aster, and heliotrope.
	12	Less than check	Somewhat toxic to all species used.
Copper-lime dust (85-15)	15	Not controlled	Injurious in some soils to sweet pea, beet, and cucumber.
	25	Not controlled	Harmless to mignonette.
	30	Less than check	Toxic to <i>Delphinium</i> but not to hollyhock.
Copper sulfate	3	Not controlled	Harmless to sweet pea and garden <i>Verbena</i> ; toxic to aster, <i>Campanula medium</i> , <i>Viola cornuta</i> , and <i>Calendula</i> .
	4	Not controlled	Harmless to beet and cucumber; toxic to mignonette.
	5	Less than check	Toxic to sweet pea, <i>Verbena</i> , beet, and cucumber.
Mercuric chloride	1.5	Not controlled	Toxic to <i>Campanula medium</i> and <i>Arabis albidia</i> .
	2.0	Not controlled	Harmless to sweet pea and <i>Dianthus</i> species; injurious to cucumber.
	2.25	Not controlled	Harmless to sweet pea; toxic to <i>Dianthus</i> and lupine.
Potassium permanganate	10	Not controlled	Harmless to all species used (petunia, <i>Arabis</i> , aster, <i>Aubrieta</i> , beet, and cucumber).
	20	Not controlled	
	30	Not controlled	

Material Tested	Grams per Square Foot of Soil Surface	Effect on Damping-off	Effect on Plants
Sulfuric acid* (sp. gr. 1.84)	9	Not controlled	Harmless to sweet pea; toxic to beet and cucumber.
	12	Not controlled	Harmless to <i>Dianthus</i> and <i>Salpiglossis</i> ; some injury to sweet pea and <i>Campanula medium</i> .
	15	Not controlled	Some toxicity to <i>Bellis perennis</i> and <i>Salpiglossis</i> ; no injury to <i>Dianthus</i> species.
Zinc sulfate	10	Not controlled	Toxic to heliotrope, aster, <i>Physostegia virginiana</i> , and <i>Bellis</i> .
	12	Not controlled	Not injurious to foxglove.
	15	Not controlled	Toxic to foxglove.

(1) Applied to soil 2 weeks before seeding.

* Applied in water at the rate of 2 quarts of each dilution per square foot.

Carnation Blight. (E. F. Guba, Waltham.) Additional varieties of carnations that were studied and classified for susceptibility to blight caused by the fungus *Alternaria dianthi* S. & H. are the following:

Very Susceptible	Slightly Susceptible	Resistant
Denver	Luminosa	Ocean Spray
Minna Brenner	Mary E. Sim	My Love
Wardelia	Patrician	Satellite
Variegated Ward	Scarlet Monarch	Woburn
Butterfly		Golden Wonder

Infestation of flatted plants with red spider mite contributed to an early epidemic infection of blight in the field as compared with a natural belated infection in the absence of mite. Further tests with potassium permanganate solution as a disinfectant for cuttings before "sanding" substantiated the previous report of the merit of this treatment. No improvement in disinfection was noted by the addition of a spreader to the solution. July benching gave three times as many No. 1 carnations as August benching. Plants made from December, January, February, and March cuttings showed no significant differences in disease control as indicated by yield. Plants housed in August and treated in the field and benches with Bordeaux 4-4-50, containing $\frac{1}{2}$ pint of fish oil, gave twice as many No. 1 carnations as similar plants not treated.

Monograph of the Genus *Pestalotia*. (E. F. Guba, Waltham.) The interest manifest in this study has stimulated efforts to carry it further. During the past year exsiccata collections from the Berlin Botanical Museum and from Dr. Charles Fairman were examined, making possible much progress in the work.

Forcing *Gladiolus* with the Aid of Artificial Light. (L. H. Jones.) Supplementing daylight with artificial light from 500-watt bulbs is a practical method for securing blossoms of gladiolus, variety Crimson Glow. At least three weeks of this light are necessary for the formation of flower spikes, and the greatest number of spikes was obtained from plots that received ten or more weeks of light at night. It was quite noticeable that the earliest blooms were obtained from the plots that received light less than ten weeks. This bears out the results of previous experiments which show that a little light shortened the period required for blossoming, while prolonged exposure to light lengthened the period.

Plant Containers. (L. H. Jones.) Plant containers of copper and brass, with and without drainage holes, have been tested. A variety of house plants, both

flowering and foliage, did better in these metal containers than in clay pots on a dry surface. There was no sign of copper injury and a chemical analysis showed no indication that copper had been absorbed by the plant from the copper in the container.

In other tests of the effect of copper on plants, copper containers did not prove harmful to plants grown in them for a period of 200 days. Neither did solid pieces of metallic copper, buried in the soil in glass tumblers in which three crops of tomato plants were grown over a period of 225 days, have any effect on the plants. Metallic copper in powder form, however, proved injurious to plants, the effect varying with the type of plant. In some cases the plants produced yellowish or pale yellow leaves; in others, the plants were stunted and produced few if any new roots.

Jardinières are practical coverings for clay pots if they are close-fitting. However, if there is a large air space between the pot and the jardinière, better results will be secured if this space is filled with moist sphagnum moss.

An enamel paint is a satisfactory means of making clay pots nonporous. To prevent chipping, the pot should be clean and dry before the paint is applied and the pot should be painted inside as well as outside.

The ordinary clay pot is not satisfactory unless it is used on a moist surface. For use in offices and living rooms, moist sphagnum moss under the pot has proved more satisfactory than either moist sand or sponge rubber. The moist sand apparently withdraws nutrients from the pot, and the sponge rubber allows too much free water to come in contact with the pot, thereby keeping the soil too moist.

Nutrients, particularly soluble nitrogen, may find ingress or egress through the moist wall of a clay pot. The direction of the flow is determined by the concentration of the nutrients in the moist medium on which the pot rests. If the medium is sand, the nutrients are absorbed by the sand; if soil, the nutrients may pass from the soil beneath the pot through the pot wall and benefit the plant. Plants that were yellow because of nitrogen deficiency recovered in 10 days to a normal green color after the drainage holes were plugged and the pots were moved from a cinder bench to a bench of soil. Plunging pots in soil undoubtedly increases the feeding range of the potted plant in addition to cutting down water loss by evaporation from the wall of the pot.

THE CRANBERRY STATION

(East Wareham, Massachusetts)

H. J. Franklin in Charge

Injurious and Beneficial Insects Affecting the Cranberry. (H. J. Franklin.)

Control of the Cranberry Root Grub (Amphicoma vulpina). Flooding to control this insect, described in the last annual report (Bulletin 293), was tried on another bog this season, the winter flood being let off early in April and the bog being reflooded from May 17 to July 5. The treatment was again highly successful and probably may now be safely regarded as very reliable.

Pyrethrum Dust. (Dr. E. A. Richmond, employed locally by the Crop Protection Institute, cooperating.) Research work with pyrethrum dust mixtures was continued extensively during the past season. Satisfactory power machines for applying the dust on a large scale were developed by local manufacturers, and

hundreds of acres were dusted commercially. In both the research and commercial dusting, all the dusts used were mixtures of fine ground pyrethrum flowers and 300-mesh gypsum. Following is a summary of the results of the season's experience with these dusts (the pyrethrum dust used in the mixtures having a 1 per cent pyrethrin content in all cases).

Insect	Stage of Growth	Pounds of Mixture per Acre	Per Cent Pyrethrum Dust	Control
Gypsy Moth (<i>Porthetria dispar</i> L.)	Caterpillars (well-grown)	100 200	40 50	50 per cent Complete
Cranberry Spittle Insect (<i>Clastoptera vittata</i> Ball)		150	50	Satisfactory
Cranberry Black Bug (<i>Plagiognathus repetitus</i> Knight)		150	33 1/3	90 per cent
False Army Worm (<i>Xylena nupera</i> Lint.)	Worms	100	33 1/3	Good
Brown Cranberry Spanworm (<i>Ematurgia amitaria</i> Gn.)	Worms	100	33 1/3	Good
Blackheaded Fireworm (<i>Rhopota vacciniana</i> Pack.)	Worms Worms Moths	100 100 100	25 20 20	Very good Often effective Very Effective
Cranberry Girdler (<i>Crambus hortuellus</i> Hubner)	Moths	100	20	Very Effective
Green Cranberry Spanworm (<i>Itame sulphurea</i> Pack.)	Worms (all stages)	100	30	Good
Blunt-nosed Leafhopper (<i>Ophiola striatula</i> Fall.)	Young stages Young stages Later stages	100 100 100	15 10 30*	Satisfactory Often effective Satisfactory
Cranberry Weevil (<i>Anthonomus musculus</i> Say)		100	50	Not appreciable

*Since this mixture is strong enough to materially reduce infestations of several other important bog pests, its use is perhaps advisable in spite of the cost. The last week in June is probably the best time to treat this leafhopper, all things considered.

Work with Chemical Weed Killers. (W. H. Sawyer.) In preliminary tests from July 28 to August 29, 1932, to find out the effects of weed killers on cranberry weeds and cranberry vines, the following chemicals were tried in different strengths of solution and sometimes in combination with one another: Sodium chlorate, iron sulfate, copper sulfate, sodium arsenite, sodium arsenate, sodium chloride, calcium chloride, ammonium chloride, sodium hydroxide, sodium bisulfate, calcium hypochlorite, zinc chloride. Of these twelve chemicals, sodium arsenate seemed to promise best results. Sodium arsenite and sodium chlorate proved to be excellent killers for cranberry weeds, but in concentrations effective on weeds also killed cranberry vines equally well. The highest differential between injury to weeds and injury to cranberry plants was secured with weak solutions of sodium arsenate. As low a concentration as 10 pounds per acre in 550 gallons of water, applied as a spray, was found to effect a complete kill of the aerial portion of wild bean (*Apios tuberosa*) with no noticeable injury to cranberry vines. Brambles and some of the lesser weeds were also killed, but on poison ivy the sodium arsenate was ineffective in concentrations low enough not to injure cranberry vines.

Weather Observations. (H. J. Franklin.) Further records bearing on frost forecasting were made for the Station by observers at East Wareham, North Harwich, East Gloucester, Carlisle, Fitchburg, Worcester, and Holliston. These records and those of previous years were studied intensively, and the formulae for predicting minimum bog temperatures were carefully revised to accord with them.

COOPERATIVE CRANBERRY INVESTIGATIONS

Conducted by the Bureau of Plant Industry, United States Department of Agriculture, in cooperation with the Massachusetts Agricultural Experiment Station.

H. F. Bergman, Senior Pathologist, U. S. D. A., in Charge.

Development of Strains of Cranberry Resistant to False Blossom. (H. F. Bergman, W. E. Truran, and Jos. L. Kelley.) Selected wild vines collected in Maine in 1932 were set out on the State Bog. Most of the vines made good growth and will be ready for propagation in 1934. Seedlings have been grown from seeds of fruit from naturally pollinated flowers of the Early Black, Howes, and McFarlin varieties to determine whether or not variations in the resistance to false blossom will be found in seedlings segregating out in the progeny. Seeds from reciprocal crosses of Early Black and McFarlin made in 1932 were planted, but none of the seeds germinated.

Oxygen Content of Flooding Water in Relation to Injury to Cranberry Vines. (H. F. Bergman and W. E. Truran.) Further experiments were made to determine the effect of the absence of oxygen in winter-flooding water on the development of terminal and fruiting buds during the following season. They indicate that low oxygen content in the winter-flooding water causes a retardation of development of terminal buds and, when oxygen content approaches complete absence, many of the terminal buds are killed. Flower buds of Early Blacks and Howes on the State Bog and some other nearby bogs were tagged and their development was followed throughout the growing season. Counts of fruit set from these buds indicate, as in last year's counts, that on the basis of the total number of fruits set from the total number of uprights examined, with one exception, more fruits were set from large or medium sized terminal buds than from small ones. The exception was found in one section of Howes on the State Bog where the winter flood was shallow. Here 48.3 per cent of the flower buds from small terminal buds set fruit as against 42.9 per cent for the medium and 41 per cent for flowers from large terminal buds. In deeper water on the same section the fruit set from flowers from large terminal buds was 41.2 per cent; from medium, 35.8 per cent; and from small ones, 31.8 per cent. These variations have not been correlated with oxygen content of the winter-flooding water.

Regeneration of False Blossom Bogs. (H. F. Bergman and Jos. L. Kelley.) Commercial weed killer (sodium arsenite) was applied to only one bog during the past season. The weed killer was applied on two plots: on one at the rate of 800 gallons per acre; and on the other, 1000 gallons per acre. The higher rates of application appeared to be more satisfactory than lower ones.

Experiments were started on another bog to determine the effect of heavy sanding, and of heavy sanding plus use of fertilizer, on the reduction of the amount of false blossom.

Vines of the Howes variety on these experimental plots showed a marked improvement both with sanding alone and with sanding and subsequent fertilization, as compared with untreated areas.

Spraying Experiments with Bordeaux Mixtures. (H. F. Bergman, W. E. Truran, and Jos. L. Kelley.) Spraying experiments similar to those of the preceding year were carried out during the past season. Spraying experiments on one of the bogs previously used were discontinued and experiments were begun on two other bogs. In nearly all instances this season two applications of spray proved to be as effective in controlling fungous rots as three. All sprayed plots, however, showed improvement over unsprayed plots, although in a few instances as much as 15 to 20 per cent of rot was found on plots which had been sprayed two or three times.

In order to test the effect of Bordeaux spray when applied to open flowers, about 100 uprights on each of 12 to 14 plots were tagged. Each upright had some open flowers and some unopened buds. These uprights were examined again late in the summer to determine the number of fruit set. The average set for all blossoms, including both sprayed and unsprayed, was 33.8 per cent; for those sprayed when open 34.3 per cent; for those sprayed in unopened bud stage 28.1 per cent. There is no indication that applying Bordeaux to fully open flowers causes any reduction in the number of fruit set.

Storage Test of Cranberries. (H. F. Bergman and W. E. Truran.) Berries from experimental spray plots stored in the basement of the State Bog building at air temperature showed less loss from fungous rots than those from unsprayed plots. Most of the loss occurred early in the storage season. With berries of early varieties, nearly all of the fruit from unsprayed plots was rotten by November 15, while those from plots receiving two or three applications of spray have shown a loss of only about 30 to 40 per cent up to December 15. Berries of late varieties have shown a similar behavior, but the rot has not developed as early as in the early varieties. Berries from plots which were sprayed twice have kept as well as those from plots sprayed three times.

DEPARTMENT OF DAIRY INDUSTRY

J. H. Frandsen in Charge

The Effect of High Initial Aging Temperatures on Certain Physico-Chemical Properties of Gelatin Dispersions. (W. S. Mueller.) The results of this investigation have been published in *Industrial and Engineering Chemistry* 25:707, June 1933.

Studies on Melting Ice Cream. (W. S. Mueller.) Investigational work on the use of higher aging temperatures in the manufacture of ice cream has revealed a new cause for excessive retardation and curdled appearance of melting ice cream. The results of the experiments have been published in the *Ice Cream Trade Journal*, October 1933.

A Study of the Use of Higher Aging Temperatures in the Manufacture of Ice Cream. (W. S. Mueller and J. H. Frandsen.) A full report of this investigation has been published in Bulletin 302.

The Theoretical Causes of the Factors Involved in the High Initial Aging Temperature Phenomena. (W. S. Mueller.) The effect of high aging temperatures on the Tyndall phenomenon of gelatin-water solutions is being studied. The accuracy of the instrument used in making these Tyndall observations

depended largely on the human eye, which at best is never exact. A new Tyndall-meter, using photo-electric cells, is being developed in order to attain greater accuracy.

Stabilizers for High Fat Ice Cream. (W. S. Mueller.) During the past few years a number of ice cream manufacturers have been selling an ice cream high in fat (16-24 per cent). This brings up a new problem; namely, what is the best stabilizer for this new product? Very little experimental work has been reported on the stabilization of high fat ice cream. The purpose of this study is to determine the amount of gelatin needed for high fat ice cream, and also to determine the advantages and limitations of the following proposed gelatin substitutes as a high fat ice cream stabilizer: Krabyn, Hygell, Yelkin, Kelco-gel, Lakoe, Galagum, and Pectin. Some of these proposed stabilizers will also be used in conjunction with gelatin.

A chemical analysis of the stabilizers to be used in this study has been made by E. B. Holland, Department of Plant and Animal Chemistry. Studies on the effect of these various stabilizers on the quality of the ice cream have not progressed sufficiently to make possible definite conclusions.

The Effect of Aging temperature on the Bacterial Count of the Ice Cream Mix. (W. S. Mueller and R. L. France.) This research has shown definitely that a pasteurized ice cream mix may be aged for six hours at 68° F. with no significant increase in bacterial count. Indications are that a mix may even be held 10 hours at 68° F. with no significant increase in bacterial count. These results are contradictory to a general belief in the ice cream industry that a pasteurized ice cream mix must be cooled to approximately 40° F. immediately after homogenization in order to avoid marked increases in bacterial growth. Probable reasons for this lag in bacterial growth are being studied.

Some Factors Affecting the Properties of Whipped Cream. (W. S. Mueller, M. J. Mack, and H. G. Lindquist.) The purpose of this project is to study factors, either neglected or inadequately studied in previous research, which affect the whipping of cream and the stability of the finished product.

Some previous studies on whipping cream are open to criticism because manually operated whippers were used which prevented whipping under standard conditions to a given degree of stiffness. In this investigation a mechanical whipper has been connected with a sensitive wattmeter so that the whipping process can be carefully studied and controlled. Preliminary trials with this method have shown that both the rate of whipping and the stiffness of the whipped cream can be measured at any time in the process with considerable exactness. A method of this type should be used in the control laboratory as well as for research since minor differences, often overlooked in hand whipping, are easily detected with a mechanical whipper which has a constant speed.

Preliminary studies have been made on the following factors:

1. Effect of percentage of fat.
2. Effect of temperature.
3. Effect of aging.
4. Effect of delayed cooling.

A Study of Ice Creams High in Fat Content. (M. J. Mack.) A tendency towards the manufacture of richer ice cream has been evident in New England for several years. Keen competition within the industry, coupled with lower ingredient costs, undoubtedly are factors which have an important bearing on the increased use of richer ice creams.

Ice creams which are considered high in fat have a butterfat content of 18 per cent or more. In the manufacture of these rich ice creams two serious difficulties have been encountered. One is an excessive viscosity which interferes with efficient homogenization, cooling, freezing, and packaging. The other is a very undesirable melting appearance. When served, the ice cream does not melt into a creamy liquid but remains rigid as a whipped cream would. Often a clear liquid oozes from the mass. This condition is undesirable because the consumer often assumes that inferior ingredients have been used or an excessive amount of stabilizer has been added.

Results indicate that excessive viscosity can be largely prevented by using higher pasteurization and homogenization temperatures (155 to 160° F.) and homogenizing with a duo-valve machine. However, passing the ice cream mix through both valves of a two-stage machine still permits considerable clustering of the fat globules. These clusters of fat globules materially increase viscosity. Trials have been conducted with a reducing valve on the discharge line of the homogenizer, carrying from 100 to 150 pounds of pressure as far as the reducing valve. The ice cream mixture is released from further pressure as it passes through the reducing valve. This additional treatment almost entirely eliminates clustering of fat globules, and as a result the homogenized product is sufficiently low in viscosity.

Improvement in the melting appearance of ice cream high in fat content is another benefit of the procedure just discussed, for the prevention of fat globule clustering also improves melting appearance. At present a study is being made with different sugars in the hope of decreasing the resistance to melting. It is hoped that the use of glucose or some other simple sugar in combination with sucrose will prove beneficial in securing a desirable melting appearance of ice creams high in fat content.

The Vitamin C Content of Strawberries and Strawberry Ice Cream. (C. R. Fellers, Horticultural Manufactures, and M. J. Mack.) This study was planned to determine whether or not preservation of strawberries by freezing or their subsequent use in strawberry ice cream decreased the vitamin C content of the fruit. Bio-assays were conducted with guinea pigs on fresh and frozen strawberries and strawberry ice cream. The study, which was completed during the past year, showed that preservation of strawberries by freezing, with or without sugar, has no harmful effect on the vitamin C content of the fruit. The incorporation of strawberries into ice cream and the rigorous beating during the freezing of the ice cream caused no measurable loss of vitamin C. This is attributed to the low temperatures at which agitation, air incorporation, and storage of the ice cream takes place.

A Study of the Changes That Occur in the Storage of Frozen Sweet Cream. (H. G. Lindquist.) Some progress has been made, but thus far no methods have proved satisfactory in measuring the changes that occur in frozen cream.

The Comparative Efficiency of Electrically Operated Tanks versus Ice in the Cooling of Milk. (J. H. Frandsen.) Where electricity was used in cooling four cans of milk from 90° to 45° F., it was found that 1.2 KWH were required for each 100 pounds of milk; and when ice was used, 40 pounds of ice were required to accomplish the same results. Comparison in dollars and cents can best be made in each locality by using the prices for electricity and ice that prevail in the local community.

A Study of the Possibilities of Milk, Cream, and Plastic Cream in the Development of New Products such as Combinations with Honey, Fruits, and Flavors of Various Kinds. (J. H. Frandsen and C. R. Foskett.) This project is well under way. Several batches with varying percentages of honey, cream, fruits, and nuts of various kinds have already been made and partially studied.

DEPARTMENT OF ENTOMOLOGY

A. I. Bourne in Charge

Investigation of Materials Which Promise Value in Insect Control. (A. I. Bourne.) The early spring of 1933, like that of 1932, was characterized by favorable weather conditions for dormant and delayed dormant spraying and very little interruption of spraying operations resulted. The delayed dormant application of oils was made on April 20 and 21. Strong winds, which promoted rapid drying, prevailed during both days. Due to the protected position of the experimental blocks, there was no interference with the application. Following the application was a week of uniformly cold weather, with temperatures not low enough to cause any breakdown of the oil sprays but sufficient to retard the rate of bud development so that ample time was allowed for the application of oils.

The investigation narrowed down to a study of comparatively few samples which appear to be outstanding in their class and show promise of effectiveness worthy of recommendation. Oil emulsions of the General Chemical Company, of the Niagara Sprayer and Chemical Company (Peninsula Oil Emulsion), and of the California Spray Chemical Company were included in the tests. The new type of "pourable" Kleenup proved to be fully as effective as the older type and much more convenient to handle.

In the face of a comparatively light infestation, all of the oils tested showed excellent control, even at moderate dilutions. This emphasizes the fact that against a moderate infestation of red mite thoroughness of application is of even greater importance than the particular brand of oil used, and that moderate dosage is sufficient under these circumstances for satisfactory control.

Preliminary tests were made with the Vapo-Duster, a new development in the use of oil sprays. By this process refined oils, either alone or combined with highly concentrated insecticide or fungicide materials, are diluted with air to form a fog which rapidly envelops plants or trees and covers any pests present with a uniform film of the active material. In such an application oils are used undiluted with water, and the spray material is atomized and driven upon the plants and pests at considerable pressure. This method eliminates the necessity of hauling large quantities of water and the loss of time for frequent refilling. The fixed type of discharge on the present machine will require modification for adaptation to average orchard conditions. The new method, however, reduces the time of application very materially, and on those trees where thorough coverage was secured, a very high percentage of overwintering eggs of red mite was killed. The effectiveness was equivalent to that of the conventional oil sprays.

In tests against the Mexican bean beetle, Dutox, a commercial fluosilicate compound, was applied as a dust and used at dilutions of 1 part to 2 and 1 to 3 of hydrated lime. No injury to bean foliage resulted from either application. From the results of previous tests no injury would be expected from this material at these dilutions except under conditions of very high temperature and humidity.

The effectiveness of this material compared very favorably with that of magnesium arsenate, the standard treatment; furthermore, reinfestation was very slow following the application of Dutox. Manganar, a manganese arsenate, diluted with hydrated lime at the rate of 1 part to 4 and applied as a dust, caused very severe burn. Nicotine sulfate (1-800) and Red Arrow, a pyrethrum compound, (1-400) proved effective as contact sprays. They reduced the numbers of bean beetle larvae but reinfestation was rapid, and consequently with such sprays frequent applications are necessary. Tests with pyrethrum dust and a rotenone dust showed these materials to have an excellent initial effect upon bean beetle larvae but neither of them appeared to have the residual effect of the fluosilicate compound mentioned above nor did they furnish protection over as long a period as the standard treatment with magnesium arsenate.

In most of the plantings of gladiolus, where the corms had been given the dormant treatment with either hydrocyanic acid gas or naphthalene, the gladiolus thrips did not develop to serious numbers until comparatively late in the season; and in many fields well isolated from other plantings, thrips were relatively scarce throughout the season and caused practically no damage—another demonstration of the effectiveness of these dormant treatments. Collections during this season showed that undoubtedly more than one species of thrips attack gladiolus. This explains why, in some fields where the corms were treated during the dormant period and consequently were free from thrips when planted, a serious infestation developed during the early season. This strengthens the recommendation that all crop remnants, chaff, etc., be destroyed after the bulbs are pulled in the fall and that, so far as possible, weeds and grass on the margin of plantings be burned over to kill thrips hibernating there. Of the spray materials and combinations tested, the Paris green-molasses spray showed to best advantage based on the appearance of the florets as well as on the effect upon thrips. A pyrethrum dust also gave good results. Derrisol (1-600), pyrethrum spray (1-600), and a combination of nicotine sulfate (1-800) and Penetrol ($\frac{1}{2}$ of 1 per cent) proved to be about equal in value but were slightly less effective than the Paris green-molasses spray. Dusting sulfur proved to be unsatisfactory.

The studies of various substitutes for lime-sulfur, carried on in cooperation with the Pomology Department, were confined chiefly to those materials which had proved outstanding in previous tests, with the addition of two new materials recently developed which appeared to be especially promising. All of these were used in combination with lead arsenate, and the complete schedule of seven sprays was followed. The efficiency of each material was measured in comparison with the standard lead arsenate and lime-sulfur combination.

The wettable sulfurs were applied in the sprays after the special curculio following the use of lime-sulfur as a fungicide up to and including the calyx. In all cases the special curculio application comprised lead arsenate and fish oil without any fungicide.

Further studies were made on the effectiveness of Kolofog and of flotation sulfur when used throughout the season as compared with the results secured when these materials were used following lime-sulfur in the pre-blossom sprays.

A combination of magnetic sulfur and lime-sulfur with lead arsenate was also applied in a complete schedule. It was hoped such a combination would give effective control against scab, avoid the burning that usually follows lime-sulfur in summer applications, and at the same time provide a spray more economical than the commercial brands of wettable sulfurs.

The lime-sulfur-lead arsenate combination again caused more or less burn

to foliage. Little russetting of fruit was noted, however. None of the other combinations caused foliage injury.

The value of these materials in controlling disease and insect pests is shown in the following table, based on examination of the McIntosh crop at harvest.

Treatment	Percentage of Clean Fruit	Percentage of Fruit Showing Injury From:			
		Curculio	Codling Moth	Scab	
Lime-sulfur.	82.7	9.0	4.5	.4	
Lime-sulfur.	90.6	.5	1.6	6.7	}
Lime.					
Sulcoloid (entire season).	50.2	.9	2.0	47.0	
Sulcoloid (after lime-sulfur).	55.9	.6	.6	41.3	
Apple Dritomic (entire season).	49.2	.6	T	47.4	
Apple Dritomic (after lime-sulfur).	87.7	1.1	.6	8.5	
Magnetic Spray.	94.1	T	1.9	1.5	}
Lime-sulfur.					
Kolofog (entire season).	84.1	—	T	14.8	
Kolofog (after lime-sulfur).	89.1	.4	1.0	8.0	
Flotation sulfur (entire season).	98.1	.3	.3	.9	
Flotation sulfur (after lime-sulfur).	96.3	.4	1.4	.8	
Check.	1.1	49.6	13.9	92.4	

The addition of hydrated lime to the standard lead arsenate-lime-sulfur combination gave a greater percentage of clean fruit and less insect damage than when this material was omitted. It did not hold scab as well as did the combination without lime.

Sulcoloid and Apple Dritomic combined with lead arsenate proved rather disappointing in control of scab. The control of insects by these combinations was excellent and but for the large amount of scab present both of these materials would have allowed over 90 per cent of clean fruit. In fairness to these materials and their manufacturers, it should be stated that during the application of the pink spray a heavy rain interrupted the spraying, and these two materials had to be applied the day following the rain. This rain marked one of the first periods of scab infection and the delay of one day in applying these sprays allowed infection to take place. The materials merit further tests.

The combination of magnetic sulfur—lime-sulfur—lead arsenate gave excellent control of both insects and scab and allowed 94 per cent of clean fruit. Kolofog again showed to better advantage when it followed lime-sulfur in pre-blossom sprays. Flotation sulfur gave excellent results, with a slight advantage in favor of the use of lime-sulfur in the sprays before the calyx.

Even a casual glance at the record of the fruit from the unsprayed checks should answer the question, "Does spraying pay?"

Control of Onion Thrips. (A. I. Bourne.) Onion thrips were more abundant in 1933 and the infestation more uniform than for several years. Observations throughout the Connecticut Valley during the growing season revealed heavy infestations of fields of seed onions well isolated from sets, a condition that differed greatly from experience in previous seasons.

Weather conditions during June and July proved to be unusually favorable for the rapid multiplication of thrips. Weather during June was considerably warmer than normal, with very high temperatures on several days. With the exception of two heavy storms, the precipitation of the month was comparatively insignificant. July with its hot weather and accompanying drought was even more favorable for the development of thrips. This and the early maturing and harvesting of sets resulted in an unusually heavy infestation on seed onions. Although the peak of abundance occurred at the usual time (the last week of July and first of August), the rise to this point was more gradual and began much earlier than normal. Consequently seed onions particularly were subject to an unusually heavy infestation over a long period and the damage was correspondingly heavy.

While the sprays applied for thrips control gave as high a percentage of kill as formerly, migration from surrounding fields was so constant that heavy reinfestation took place very rapidly, demonstrating that in any similar season at least one and probably two extra applications would be necessary to give protection over the unusually long period of danger.

Several insecticides and combinations were tested and their effectiveness compared with the standard nicotine sulfate-soap combination. The best control was obtained from the nicotine sulfate-fish-oil soap spray. Lethane and Penetrol proved to be a close second in effectiveness. Its cost is, however, somewhat prohibitive.

The plots treated with naphthalene flakes showed comparatively slight damage from thrips, and this treatment appears to be very promising. The combined spray of Paris green and molasses, so successful in the control of gladiolus thrips, caused considerable injury to onion foliage after each application. The material DAO, a dry powder, broadcast along the rows checked the thrips but its cost is prohibitive for use in large acreages. The pyrethrum dust was shipped so late that only one application could be made. The results were so promising it is worthy of further study.

The fungous disease of thrips which was so generally distributed throughout the Valley during 1932 and caused a rapid decrease in the numbers of thrips was present this season, but was much less abundant and was later in appearing. Its appearance coincided with the normal drop in thrips abundance which occurs early in August, so that it was of much less benefit than in 1932. It was, however, present over practically the same area as in the preceding year, and leads to the hope that it might survive an unfavorable season and build up a heavy infection in a year when conditions were more favorable.

The Spray Residue Problem. (A. I. Bourne.) The recent activity of governmental agencies and the establishment of limits of tolerance for lead and for fluorine compounds upon harvested fruit and vegetables, in addition to those already fixed for arsenic, have combined to reemphasize this problem and necessitate additional investigation.

The limit of tolerance first proposed for lead was so low that further study of arsenical residue became necessary, and no tolerance on fluorine residue was recognized. These regulations were subsequently so modified for the 1933 season that drastic changes in the spray schedule were not necessary, and a limit of tolerance for fluorine residue, equal to that for arsenic, was established.

The strict limits first proposed for lead residue necessitated a study of possible substitutes for lead arsenate. Tests were made of seven different brands of calcium arsenate, a manganese arsenate, and a zinc arsenate. All of these caused

serious burning of foliage. Similar tests in commercial orchards in many cases resulted in even more serious damage than that in the college orchards. Burn was first noted following the extremely hot weather in late June, and in many subsequent instances was associated with similar periods of high temperature, particularly when accompanied with a high relative humidity. Lead arsenate in parallel tests and under the same conditions caused slight foliage burn but in no case was the injury comparable to that following calcium, manganese, or zinc arsenate.

Weather conditions during late summer and early fall, particularly during the period from the last spray or dust application until the harvesting of the fruit, were favorable from the standpoint of the residue problem. The total rainfall during August was nearly two inches over the normal and the outstanding feature of the weather during September was the unusually large rainfall of over twelve inches, a great part of which occurred just before the harvesting of McIntosh. From the residue standpoint the danger to the main varieties, McIntosh and Baldwin, was practically eliminated, and growers who dusted in the late season applications experienced no difficulty.

In cooperation with the State office of the Food and Drug Administration, samples of McIntosh and Baldwin were collected and forwarded for analyses for both lead and arsenic to determine how far the present spray schedule could be safely followed and what changes would be necessary. The results of these analyses have not been received. The excessive rainfall during August and September would so reduce the amount of residue at harvest that it is doubtful whether these figures would be applicable to a season of more normal precipitation.

Under present conditions, if a grower hopes to avoid the danger of lead or arsenical residue without the necessity of washing his fruit, it is recommended that lead arsenate in an amount exceeding 3 pounds to 100 gallons should not be applied within 8 weeks of harvest and that no arsenical spray be applied within 6 weeks of harvest. Growers who depend upon dusting, however, may safely employ at least a 90-10 sulfur-lead arsenate dust as late as 4 weeks before harvest.

Systematic Study of Oil Sprays. (A. I. Bourne in cooperation with the Department of Chemistry.) Three samples of miscible oil, prepared under identical conditions and with the same emulsifying agents, were used in the tests this season. The basic oils were paraffin base lubricating oils of approximately the same viscosity. The specific gravity of the samples was respectively 0.86, 0.89 and 0.91, and the samples varied from 75 to 86 per cent in their degree of unsulphonated residue. These were applied in a block of plums while the trees were in delayed dormant stage of bud development, to test their effectiveness against overwintering eggs of European red mite. They were used at 2 and 3 per cent strengths of the basic oils.

When mixed with water in preparation for the spray, the samples of higher specific gravity went into solution very readily. The sample of 0.86 specific gravity was emulsified with considerable difficulty and required constant and vigorous agitation. None of the samples when once in solution showed any evidence of breakdown or separation of free oil. There was no indication of burn or retarding of bud development following the application of any of these oils, at either dilution.

All of the samples gave 98 to 99 per cent control of European red mite. There was no significant difference in effectiveness in any case; but the light infestation of red mite in the college orchards made any fine distinctions in effectiveness impossible.

Apple Maggot Control. (A. I. Bourne.) A combination of favorable weather conditions, especially during the period of emergence of the flies, which allowed the insect to follow closely its normal course of seasonal development and more accurate timing of the sprays for its control, enabled growers to hold the pest in check very satisfactorily. At the same time there was sufficient evidence from unsprayed blocks to show that this control was not due to any scarcity of the insect over the State as a whole.

In the 9 orchards where control demonstrations have been conducted and in which the complete control program was continued, only 9 apples out of a total of 7,688 examined were found to be infested, an average of 0.12 per cent infestation; in 5 of the orchards no evidence of maggot injury was discovered; and in only one block did the fruit score less than 90 per cent clean. One grower, whose fruit scored less than 3 per cent clean in 1929, the year preceding the demonstration, largely because of failure to control apple maggot, secured in 1933 a crop scoring 93 per cent clean fruit with no evidence of maggot injury.

The work was extended from a demonstration in individual orchards to an attempt at a community program in so-called maggot control areas where several growers, whose blocks were located in a well-defined area more or less isolated from outside orchards, were united in a campaign to control maggot in that area. The success of such a plan depends upon the thorough cooperation of all the growers. Results showed that successful maggot control was in direct proportion to the extent to which each grower carried out his assignment.

In one area comprising approximately 15,000 trees in commercial blocks, apple maggot damage of from 5 to 10 per cent on Baldwins was recorded when a complete spray program was supplemented by the removal of wild, pasture, or roadside trees in the vicinity of the commercial orchards. Where the environmental factors were ignored, and neglected trees were allowed to remain standing, from 60 to 100 per cent of the fruit was found to be infested by maggot, and in nearby commercial blocks the fruit showed from 20 to 50 per cent infestation. Many hawthorn trees were found in this area and much of the fruit was found to contain maggots.

In a somewhat smaller area where, by the united efforts of the group of growers, all neglected trees were removed and an adequate spray program was carried out in all the commercial blocks, the infestation on Baldwins ranged from 0 to 7 per cent, with an average infestation of 1.8 per cent. In all but one case maggot damage was less than 2 per cent and in every case maggot injury was much less than that of the previous year.

Studies on the dispersal of apple maggot flies, supplementing those of Phipps and Dirks in Maine, led to recovery of flies at a distance of from 600 to 700 yards from the point of liberation. The maximum range in previous records of recovery was approximately 300 yards. This indicates that under favorable conditions these insects may fly for longer distances than previously supposed, which may account for severe outbreaks which have hitherto been baffling to explain.

Introduction of Parasites of Oriental Fruit Moth. (A. I. Bourne.) The introduction of parasites of the Oriental fruit moth was extended to practically every section of the State where peaches are grown on a commercial scale and where the infestation of Oriental fruit moth was severe enough to promise successful establishment of the parasites.

Approximately 60 colonies comprising 15,000 specimens of *Macrocentrus ancylivorus* were liberated in 8 counties of the State. In addition, liberations were made of several colonies of newly introduced parasites, some of which

appear more promising than any of the native species. The work was carried on in cooperation with the U. S. Bureau of Entomology and the liberations were made under the direction of the various county agents.

Twig collections previous to liberation indicated that the parasites were not present naturally in these counties. Similar collections made in late summer from the orchards where colonies of *Macrocentrus* were liberated showed that in every case the parasites had become well established. Further studies will be necessary to determine whether the insect can successfully winter over in all sections of the State. Recovery records from orchards in Hampden County, where liberations had been made in previous years, showed from 43 to 88 per cent of parasitism.

Plum Curculio. (W. D. Whitcomb, Waltham.) Continuing previous experiments to determine the effect of temperature on the activity of the plum curculio, 140 pairs of adult curculios were divided into 4 groups of 35 each. The groups were confined for periods of 10 and 20 days at 55°, 65°, 75°, and 85° F., after which they were transferred to the other temperatures in the series for a similar length of time. Daily records were kept of the activity of the beetles, as indicated by the number of feeding punctures per beetle and the number of eggs laid by each female. These experiments clearly verified the results of previous work which had shown a consistent increase in both feeding and oviposition with each increase in temperature.

In general the average activity of the beetles when placed in a certain temperature at any time regardless of the previous environment was consistent with the average activity during a continued exposure to that temperature. An exposure to a higher temperature increased activity, and to a lower temperature decreased activity with one exception. This exception was recorded when a 20-day exposure at 85° F. showed slightly less activity than a previous 10-day exposure at 75°. Other observations as well as this exception indicated that there is a tendency toward decreased activity at temperatures above 75°.

The average number of feeding punctures per beetle per day during 10 days at 65° F. was 3.02, while this activity during a similar exposure after a 20-day confinement at 55° was 3.54, indicating that a low temperature not only retards activity but also produces a supply of stored energy which results in a slight supernormal activity when the temperature is increased. It also appeared that a similar reaction in the opposite direction took place, when it was observed that the average number of punctures at 55°, 65°, or 75° was less after a previous exposure of 10 or 20 days at 85° than at a constant exposure to those temperatures. Oviposition records were similar but showed more variation.

Laboratory tests of several stomach poisons which might be more desirable to use than lead arsenate for combating the adult plum curculio indicated that both calcium arsenate and manganese arsenate were slightly more toxic than lead arsenate, and that barium fluosilicate and sodium aluminum fluoride were only slightly less effective and promising. Nicotine tannate, a sulfur—carbon disulfide emulsion, and a zinc sulfate—lime—derris mixture were failures in this test.

Biology and Control of the Apple Leaf-Curling Midge. (W. D. Whitcomb, Waltham.) The apple leaf-curling midge, tentatively determined as *Dasyneura mali* Kieffer, which has apparently been introduced from Europe, is now established in northeastern Massachusetts and southeastern New Hampshire. It was first observed in this country in 1928 but previous to 1933 was not known to be present outside of the town of Ipswich. Recent reports, however, indicate

that this midge has been observed but not identified at other points in the infested area during the last five years. The known infested area now covers about 1,000 square miles extending from Melrose, Massachusetts, westerly to Westford, Massachusetts, and northerly to Durham and Rye, New Hampshire. Several of the largest commercial orchards in eastern New England are now infested.

Injury is identified by the presence of tightly rolled leaves on the tips of branches and on water sprouts. The leaves are rolled from the underside upward toward the midvein and parallel to it. In heavily infested specimens the entire leaf forms two tight rolls. All varieties of apples grown in the orchards under observation were infested, but Baldwin, Delicious, and McIntosh appeared most susceptible, while Wealthy was almost immune. The growth of nursery trees and grafts is noticeably delayed and stunted by the activity of this midge, but on bearing trees the size, color, and abundance of fruit were not conspicuously affected during the present season.

There appear to be four generations annually, the first midges emerging about June 1, and requiring approximately 5 weeks to complete their life cycle. The abundance of the third and fourth generations depends on the number of water sprouts available. The eggs, which are laid on the unfolding leaves of terminal growth or water sprouts, hatch in 3 to 5 days, and the tiny white maggots feed for about 20 days within the tightly rolled leaves. When mature, the maggots are bright orange in color and usually fall to the ground where they spin a small white cocoon just beneath the surface of the soil. Pupation requires 13 to 18 days.

On water sprouts the majority of the infested leaves turn black and fall after the maggots have left them, but on terminal shoots many of the rolled leaves remain throughout the season.

Two natural enemies, a predatory bug and a parasitic hymenopteron, were reared from leaves infested by the midge, and promise to aid in controlling this pest.

Biology and Control of the Carrot Rust Fly. (W. D. Whitcomb, Waltham.) As in the two previous seasons, field infestation by the first generation of the carrot rust fly was negligible, and untreated carrots as well as those receiving insecticide applications were practically free from injury. The only infested carrots were found where the plants were watered daily during the oviposition period by overhead irrigation, and only 3 per cent of these were infested.

Injury by the second generation reached 26 per cent in the untreated plot and was greatest in the plot receiving overhead irrigation, where 32 per cent were infested. This further demonstrates the previously reported theory that cool, damp soil is favorable to this pest.

Of the dust treatments, which were applied July 31, August 7 and 14, and September 5 and 12, naphthalene was most efficient, with 98 per cent clean carrots. Soot and two dusts containing derris gave 90+ per cent control, and tobacco and two dusts containing mercury gave 80+ per cent control. Kainit was quite effective, but killed many seedling carrots and caused a poor yield. The treatment of seed with calomel or corrosive sublimate combined with gypsum in varying quantities reduced injury 10 to 15 per cent, but the results were not consistent with the amount of mercury used. Seed treated with pure calomel yielded 92 per cent clean carrots.

Adaptability of *Cryptolaemus* to Control of Mealybugs in the Greenhouse. (W. D. Whitcomb, Waltham.) The Australian Mealybug Destroyer, *Crypto-*

laemus montrouzieri Muls., can be secured from California at a very reasonable cost. The adult beetles are shipped by air mail and several shipments have been received in Massachusetts in good condition except during extremely unfavorable weather in winter. Both adult and larval stages of this ladybug feed on the greenhouse mealybug.

In the greenhouses at the Waltham Field Station extremely heavy infestations of mealybugs on gardenias have twice been satisfactorily controlled by liberating *Cryptolaemus* beetles at the rate of about 1 beetle per plant. When the beetles were liberated in January, the mealybugs were under control about 60 days later. When the beetles were liberated in August, perfect control of a most severe infestation was accomplished in 30 days.

Preliminary studies of the relation of temperature to the development of *Cryptolaemus* indicate that temperatures of 70° or above are desirable for efficient activity. It required four times as long for eggs to hatch and pupation to be completed at 60° F. as at 80°, indicating that these beetles will not thrive at low temperatures. Isolated pairs lived four months at average greenhouse winter temperatures and laid eggs intermittently throughout their whole life. The maximum number of eggs laid by one paired female was 107. The estimated increase from one generation in the greenhouse was 600 per cent.

Naphthalene and Similar Materials as Greenhouse Fumigants. (W. D. Whitcomb, Waltham.) Experimental fumigations of chrysanthemums with naphthalene have continued to indicate that this crop cannot safely withstand this treatment. Injury is usually shown by blindness or deformed bud development, and a varietal susceptibility is apparent. Major Bonnafon, Friendly Rival, and Halliday are among the varieties most susceptible to naphthalene blindness.

It was also demonstrated that the fumes discharged during the first two hours of a fumigation are largely adsorbed by the plants, soil, and equipment, so that the effect on red spider is negligible until after an exposure of three hours or longer.

Experiments with two commercial liquid fumigants in which the toxic benzene-ring products are dissolved in a non-injurious solvent have shown them to be effective for controlling red spider. Unlike crystal naphthalene, these fumigants do not become injurious at the minimum temperature for growing greenhouse plants, although their efficiency is decreased below 60° F. Most varieties of plants which tolerate naphthalene fumes will tolerate these materials, but cucumbers have been severely injured in all experiments.

Control of Red Spider on Greenhouse Crops. (W. D. Whitcomb, Waltham.) Preliminary studies on the relation of temperature to the effectiveness of some common commercial preparations used for combating red spider in the greenhouse indicate that this factor exerts an important influence.

On potted carnation plants an alcoholic extract of pyrethrum and soap gave 34 per cent greater kill of red spider at 60° F. than at 80°, and a 24 per cent greater kill when additional soap was added. Another pyrethrum extract with additional soap was 23 per cent more effective at 60° F. than at 80°. On the other hand, a selenium preparation was 49 per cent more effective at 80° F. than at 60°, while the effectiveness of a sulfur-carbon disulfide emulsion was not influenced by temperature.

DEPARTMENT OF FARM MANAGEMENT

R. L. Mighell in Charge

Enterprise Relationships and Farm Organization on Selected Dairy Farms in Massachusetts. (R. L. Mighell.) This study is concerned with the economics of the combinations of farm enterprises and of cost factors within each enterprise. Research along the latter line has taken the form of replanning labor routine and equipment for the most economical and efficient performance of regular daily tasks on dairy farms. In cooperation with W. C. Harrington, of the Agricultural Engineering Department, typical barn plans for 10-, 20-, and 30-cow capacities are being studied from the standpoint of efficient utilization of labor. As a preliminary step in this study an imaginary man is conceived of as doing imaginary chores, in a number of imaginary barns. Each imaginary barn is represented by a blueprint and as the chores are performed on paper, distances are measured, time is estimated, and other considerations of convenience are studied. As a final step, the most hopeful arrangements are checked in actual barns under real conditions. A number of interesting tentative conclusions have already been reached. For example, facing cows out proved to be usually more economical in terms of time and distance than facing cows in, contrary to a widely prevalent belief.

Another part of this project which is now being emphasized is a study of the economics of pasture improvement. This problem is one of finding the most profitable combination of enterprises and of cost factors such as fertilizer and labor. The study is being developed by using the budget method with typical cases representing conditions under which pasture improvement should or should not be recommended. An attempt is being made to develop a workable plan or method of approach which the individual dairyman can use in solving the problem for his own case.

Labor Saving Methods and Technique on Vegetable Farms. (R. L. Mighell and R. H. Barrett.) This study represents one of the first attempts in the United States to apply the so-called "Taylor System" of scientific management and time and motion study to agriculture. During 1933 a careful, intensive study has been made of labor-saving technique and equipment for asparagus, one of the important vegetable crops in Massachusetts. Supervised records, motion pictures, and close study and observation of typical farm set-ups, and of suggested changes have yielded significant results. In one important asparagus area a complete change in the type of asparagus bunching equipment and technique has been recommended as a result of the study. This change is now being adopted by growers in this area, with considerable saving in time and effort devoted to the task of bunching.

Economical Use of Labor in Silage Production on Dairy Farms. (R. L. Mighell and R. H. Barrett.) Continuing an intensive study of various types of wagons used in filling silo, initiated in 1932, motion pictures and time records were taken in September and October 1933. The time and motion records show clearly that the low down wagon saves an immense amount of human time and effort on such tasks as silo filling. The underslung type of low down wagon is apparently the simplest and easiest to make, and can be easily constructed by any farmer. Dump carts and other high wagons still in use by many New England farmers are very wasteful of time and energy both in loading and unloading.

Tests and observations on a few farms indicate that a mowing machine with a 5-foot cutter bar may prove very satisfactory for cutting silage corn in the field.

Nearly every dairy farmer has a mowing machine anyway, and in cases where the silage corn acreage is not sufficient to justify the purchase of a binder, the mower may prove to be the most economical method of harvesting.

FEED CONTROL SERVICE

Philip H. Smith in Charge

The Feed Control Service comprises not only feed inspection, but several other activities, as listed below:

Feed Control (General Laws, 1920, Chapter 94)

Seed Control (General Laws, 1927, Chapter 94)

Dairy Law (General Laws, 1920, Chapter 94)

Advanced Registry Testing

Miscellaneous Work

Feed Control. (P. H. Smith, A. F. Spelman, J. W. Kuzmeski, F. A. McLaughlin, J. T. Howard.) During the fiscal year, 1,649 samples of feeding stuffs were officially collected and examined in the control laboratories. The results show that at least 97.7 per cent of the samples collected varied less than 1 per cent from stated guarantees in protein, fat and fiber content. The gross receipts from the registration of feeding stuffs in 1933 (calendar year) were \$20,860, derived from 1,043 brands at \$20 each.

Seed Control. (P. H. Smith, F. A. McLaughlin, Margaret E. Nagle.) From October 1, 1932, to October 1, 1933, the Seed Testing Laboratory analyzed 1188 seed samples, 507 of which were collected by the State Department of Agriculture, 180 submitted by dealers and farmers and 191 by the Rhode Island Department of Agriculture, 266 purchased from wholesalers for special tests, and the remaining 44 accounted for by germination tests of ingredients of grass seed mixtures.

	Massachusetts Official	Massachusetts Non-official	Rhode Island	Total
Purity analysis only	38	28	36	102
Laboratory germinations	323	419	3	745
Field germination	0	(266)*	0	...
Purity and germination	146	43	152	341
	507	490	191	1188
Field crops	26	26	25	77
Forage crops	158	121	164	443
Vegetables	323	334	2	659
Flower seeds	0	3	0	3
Tree seeds	0	6	0	6
	507	490	191	1188

*266 field tests are duplications of laboratory tests, portions of the same samples being used.

Field tests to determine trueness to type were again conducted in conjunction with the Department of Vegetable Gardening, which tested 266 samples of sweet corn.

Dairy Law. (P. H. Smith, J. T. Howard, H. L. Allen.) During the year ending December 1, 1933, 6,334 pieces of Babcock glassware were tested. Condemned glassware consisted of three milk-test bottles and one pipette. One hundred and five certificates of proficiency were awarded.

One hundred and ninety-four creameries, milk depots and milk inspectors' laboratories were visited in order to check methods and pass upon equipment in use. As a result of this inspection, three machines were condemned, and repairs were ordered on seventeen. Seven plants were re-inspected to approve repairs. Special investigations were made at nine plants.

Advanced Registry Testing. (P. H. Smith.) Advanced registry testing has been supervised by this department since its beginning in 1902. There are now on yearly test 328 cows located on 51 different farms. This does not include the herd tests where all animals in each herd are placed on test. Of these there are twenty-one, seven of which are supervised by men sent out from this office and fourteen by cow-test association supervisors.

Miscellaneous Work. (P. H. Smith, A. F. Spelman, J. W. Kuzmeski.) Numerous analyses have been made for residents of the State and other departments of the college.

Summary of Miscellaneous Work, 1933

Materials sent in:

Milk and cream, butterfat only	182
Milk, solids and fat	3
Ice cream	7
Feeds, from farmers and dealers	80
Feeds, from State Institutions	121

For other departments of Experiment Station and College

Milk, for butterfat	309
Dry matter, forage crops	2,235
Complete fodder analyses	84
Dry matter and nitrogen	94

FERTILIZER CONTROL SERVICE

H. D. Haskins in Charge

Fertilizer Inspection. (H. D. Haskins, H. R. DeRose, A. F. Spelman, J. W. Kuzmeski.) Records for the year show that 144 firms have registered for sale in the State of Massachusetts 495 brands of mixed fertilizer and fertilizing materials and 40 brands of agricultural lime and gypsum. The following summary shows the character of these substances, as well as statistics with reference to their inspection.

During ten weeks following April 1, four experienced men employed to draw samples for inspection purposes sampled 19,152 sacks or containers, representing 7,751 tons of material; 875 agents were visited.

	Brands Registered	Brands Collected	Samples Collected	Number of Analyses	Number of Determinations*
Mixed fertilizers	301	285	1,051	441	5,761
Ground bone, tankage and fish	53	51	152	61	294
Nitrogen products, organic and mineral	51	45	208	109	265
Phosphoric acid products	22	21	95	29	116
Potash products	10	10	58	17	44
Dried pulverized natural manures	31	30	97	32	216
Nitrate of potash	4	4	8	5	20
Miscellaneous	28	28	25	16	116
Lime products	40	40	65	41	351
Totals	540	514	1,759	751	7,183

*Not counting check tests or repeats, which amount to more than 1,000.

During the period July 1, 1932, to July 1, 1933, the tonnage of fertilizer and plant food sold in Massachusetts was as follows:

	Fertilizer (Tons)	Plant Food Elements (Tons)		
		Nitrogen	Phosphoric Acid	Potash
Mixed fertilizers	37,076	1,845	3,078	2,408
Unmixed fertilizer chemicals and materials	16,451	1,187	1,343	400
Pulverized natural manures	1,443	31	21	40
Totals	54,970	3,063	4,442	2,848

Full details of the fertilizer and lime inspection will be found in Bulletins 69 and 71, Control Series.

Miscellaneous Analytical and Diagnostic Work. (H. D. Haskins, H. R. DeRose, A. F. Spelman, J. W. Kuzmeski.) Chemical investigations of a co-operative nature have been carried on, as has been the usual custom, with other departments of the institution, the Waltham Field Station, County Agents, etc. The character and extent of this work is shown from the following summary:

Artificial manures (nitrogen studies)	87	Cured hay	35
By-product fertilizers	3	Lead arsenate	1
Carnation blooms	2	Lime products	2
Citron	2	Manures	2
Complete fertilizers, home mixed and officially collected	17	Miscellaneous	2
Dried turnips	2	Peat products	5
Fertilizer chemicals	5	Tobacco soils	5
		Fish meal	5
		Greenhouse soils	2

The chemical work of the department has also included service to farm organizations, State institutions, community interests, as well as to individuals interested in agriculture. Reports in all cases have included interpretations and advice with reference to the problems involved. This group includes the following materials:

Agricultural lime products....	9	Manures, pulverized.....	3
Ashes, cotton hull and incinerator.....	4	Manufacturers' by-products	11
Complete fertilizers.....	32	Miscellaneous.....	3
Fertilizer chemicals and unmixed materials.....	14	Peat products.....	14
Insecticides and fungicides....	4	Stomach contents for mineral poisons.....	3
		Soils.....	52

As in the past, contact and cooperation have been maintained with the Association of Official Agricultural Chemists of North America.

DEPARTMENT OF FLORICULTURE

Clark L. Thayer in Charge

Breeding Snapdragons for Varietal Improvement and Disease Resistance. (Harold E. White, Waltham.) The study of rust resistance in snapdragons has progressed to the F_3 generation. Succeeding generations have resulted in reduction in hybrid vigor due to continued inbreeding. This has been manifested by a decrease in size of individual flowers and height of plants. Resistance to rust in the different strains in the F_3 generation has varied from 75 to 90 per cent, and in one strain to 100 per cent. In most strains yellow and white colors have bred 100 per cent pure in the F_3 generation. Resistant plants from the F_1 generation have maintained their resistance, even under field conditions, for three years.

Resistance in all cases observed appears to be complete, with practically no partial resistance. It would appear from data collected that resistance may be linked to some factor since there is a tendency for resistance and white color to stay together a greater number of times than resistance with yellow. Further study will be necessary to prove definitely any color linkage for resistance. A brief paper on this work was presented at the meetings of the American Society for Horticultural Science in 1933.

Study of the Effect of Plant Nutrients on Carnations Under Glass. (Harold E. White, Waltham.) When calurea, Cal-Nitro, ammonium sulfate, urea, calcium nitrate, and sodium nitrate were used as nitrogen sources, using a 4-12-4 as a basic fertilizer, the calurea and Cal-Nitro plots ranked first in production over the other materials. This rating has been observed for two years on experimental plots. Such results under experimental conditions would indicate that a combination of ammonia and nitrate nitrogen is preferable to straight nitrate sources.

Plots receiving no phosphorus produced six less flowers per square foot, whereas those receiving no potash produced eight less flowers per square foot. Plots receiving all the fertilizer elements as a complete fertilizer produced only two flowers less per square foot than plots receiving all the potash and phosphate prior to planting. Experimentally the difference is not great, but from a commercial standpoint it might be significant.

When bone meal was used as a source of phosphorus in comparison with superphosphate, the production was lowered six flowers per square foot. Nitrophoska, used as a partial source of phosphorus in combination with superphosphate, resulted in no great difference.

Fertilizer studies with roses have been discontinued due to lack of greenhouse space in which to grow this crop properly.

Varietal and Cultural Observations on China Asters. (Harold E. White, Waltham.) Some 60 strains of asters were grown in the field for observation of the behavior of wilt-resistant strains under New England conditions. Plantings were made in soil where two years before aster wilt was quite prevalent but even though non-resistant strains were included, wilt was practically nil in the 1933 plantings. Aster yellows was unusually severe—equally so on all strains with the exception of Queen of the Market which, although showing decided symptoms of yellows, was less severely affected by the disease than the late varieties. One explanation, other than by a resistance factor, might be on the basis that this variety carries far less foliage than the other strains, thus offering less feeding area for leafhoppers. One plant was found which showed probably inherited resistance. Selections were made for further study on yellows resistance.

The standard aster cloth, 22 x 22 threads per square inch, used for commercial culture of china asters would appear to be better than heavier grades. Three tents were used with the following results:

Cloth Used (Threads per square inch)	Light Transmitted (Per Cent)	Relative Production of Flowers
44 x 40	62	100
32 x 28	74	118
22 x 22	81	200

Chrysanthemums came into bloom 10 days earlier under cloth than under glass.

This experiment was made possible through the courtesy of the Lewis Manufacturing Company, Walpole, which supplied the cloth.

DEPARTMENT OF HOME ECONOMICS

Bernice Wait in Charge

The Comparative Value of Milk and Tomato for Supplementary Feeding in Elementary Schools. (B. Wait and M. V. Cowing.) For the preceding three years the children in a small consolidated rural school were given a supplementary mid-morning feeding, at first of either milk or tomato and later of a combination of evaporated milk and tomato juice. This study has been continued for a fourth year by feeding the children of a control school to ascertain whether any results of the feeding which seemed apparent could be duplicated in this latter group. Insofar as it has been completed, the analysis of the data tends to confirm the observation that there was some, although not marked improvement in the general well-being of a majority of the children as a result of the feeding in both schools, whether of milk or tomato or both.

The Value of Evaporated Milk for School Food Service. (B. Wait and O. A. Merriam.) This project is similar in purpose and in method to the above. Throughout two school years the children of the first four grades of the school in a small mill village were given a mid-morning feeding of eight ounces of reconstituted evaporated milk daily. The general condition of these children at the beginning and the end of the school year was determined by medical and dental examinations, and their growth, school progress, school attendance, and incidence of colds during the school year were observed. These same observations were

also made of a control group of children of the same grades in a school in a neighboring village. The control group was fed this year. As in the project above, insofar as the analysis has been completed, the data seem to indicate some improvement in the general well-being of the children in the experimental groups.

DEPARTMENT OF HORTICULTURAL MANUFACTURES

W. W. Chenoweth in Charge

Technological Investigations and Nutritive Value of New England Fruit Products. (C. R. Fellers and J. A. Clague, with the assistance of G. G. Smith.) The vitamin C content of 17 varieties of apples has been determined by the guinea pig bio-assay method. A marked difference among varieties was noted: Baldwin and Northern Spy had the highest vitamin C values; Spitzenburg, Roxbury Russet, King, Gravenstein, Winesap, Rhode Island Greening, and Wealthy were intermediate; and Delicious, King David, Tolman Sweet, and McIntosh were very poor in this factor. The bio-assay of other varieties is being continued.

The spraying of apple trees with lead arsenate sprays had no effect on the vitamin C content of Baldwin apples. Previous preliminary data reported (*Proceedings of the American Society for Horticultural Science* 30 (1932): 93-97, 1933) on the distribution of vitamin C in the epidermis, flesh near the epidermis, and flesh near the core were confirmed. There is a definite increase in vitamin C in the outer layers of the flesh of apples.

Apple butter, boiled cider, and vinegar retained only traces of vitamin C. Regardless of the method of manufacture, apple sauce retained only 10 to 20 per cent of the original vitamin C content of the fruit.

The clarification of fresh cider was studied with a view to determining the most effective and inexpensive methods. Tests were made with enzyme preparations, gelatin-tannin precipitation, and filtration. Both the gelatin-tannin and the enzyme methods followed by filtration gave clear, sparkling ciders of high quality. Ten varieties of apples were studied for their cider making qualities, especially with respect to sugars, acids, pectin, and tannin.

Manufacture, Preservation, and Nutritive Value of Cranberry Products. (C. R. Fellers, J. A. Clague, and P. D. Isham.) About 10 additional varieties have been examined during the year for suitability for strained and whole sauce manufacture. Data have now been obtained on 60 varieties. Frozen cranberries were found to make good quality canned cranberry sauce, and several canners are now utilizing this information by freezing several thousand barrels annually for sauce manufacture during the off-season. Sauce made from such frozen berries is superior in color and quality to canned cranberry sauce which has been held in storage for several months.

The jelly strength tester developed by this department (*Industrial and Engineering Chemistry, Analytical Edition* 4:106, 1932) has been successfully used to determine the jelly strength of canned cranberry sauce. This is of importance because sauces showing strengths of less than 100 grams break down in shipment.

A new method of preparing candied cranberries has been developed. Briefly, the pricked fresh cranberries are placed in a 70 per cent sugar syrup in a vacuum pan and thoroughly exhausted. This impregnates the fruit with syrup. After drying, the fruit retains its excellent color and flavor and keeps well. Additional research has also been conducted on cranberry juice.

A very complete study of the vitamins of cranberries and cranberry products has been completed and published as Bulletin 296. The cranberry is a good source of vitamin C and contains small amounts of vitamin A.

Nutrition investigations of the effects of cranberries on urinary acidity and blood alkali reserve of human subjects have been completed and published in the *Journal of Nutrition* 6:455-463, 1933. Cranberries in the amounts normally eaten have no significant effect on urinary acidity or blood alkali reserve. Large doses increase the former and decrease the latter because of the presence of quinic and benzoic acids in the cranberry.

Intensive chemical work on the separation of the acids of the cranberry has not been entirely successful. No method has been found by which the quinic acid may be quantitatively extracted from cranberries. A chemical study including benzoic acid determination was made on ten leading varieties of cranberries. The benzoic acid varied from 0.035 to 0.095 per cent. A paper on this work has been accepted for publication by the *Journal of Plant Physiology*.

Utilization of Onions by Drying. (C. R. Fellers.) Cull Connecticut Valley onions were again successfully dried and manufactured into a dry white powder which retains to a remarkable degree the characteristic flavor of the fresh onion. A description of this product, method of manufacture, and uses was published in *Food Industries* in October 1933.

A start has been made on the study of onion pickling as a possible use of unmarketable onions. The small onions cure better in a 15 per cent salt brine than in weaker brines. Scarcely any lactic acid fermentation takes place in a 15 per cent brine, but the onions keep perfectly.

Nutritive Studies on Tomato Juices. (C. R. Fellers, J. A. Clague, B. Wait, and M. J. Mack.) Commercial canned or bottled tomato juices varied widely in their vitamin C content, some being only one third as valuable as others. These juices were utilized by the Home Economics Department in their research on the supplementary feeding of school children.

In general, homogenization of tomato juices had an adverse effect on their vitamin C content. However, the appearance was greatly improved because homogenized juices were very stable and the solids did not settle out.

Blueberry Investigations. (C. R. Fellers and P. D. Isham.) Blueberries were found to be good sources of vitamin C and to contain small quantities of vitamin A as well. Freezing did not injure the vitamins of the fruit. The canning tests were inconclusive in that some samples showed considerable vitamin C retention, while others did not. The results are published in the *Journal of Agricultural Research* 47:163-165, August 1933.

Feeding tests on human subjects showed that the ingestion of large amounts of blueberries had no effect on urinary acidity or blood alkali reserve. Likewise, they yielded no benzoic acid upon analysis.

Red Squill Research. (Robt. E. Buck and E. M. Mills.) This study is financed by the U. S. Biological Survey and has for its purpose the perfecting of red squill rat baits. Active laboratory work is under way on the preparation of alcohol, glycerol, and other squill extracts for use in combination with fish, meat, and cereals for rat baits.

Nutritive Value of Fish Meal. (M. M. Cleveland.) This research is financed by the Russia Cement Company of Gloucester. Comprehensive studies have been under way for nearly two years on the value of fish meals prepared in various

ways. As a sole source of protein for rats, fish meal from which the glue has been extracted is superior to unextracted fish meal. Similarly, the vacuum-dried meals gave better weight gains with rats than flame-dried. In cooperation with the Poultry Department, work is being conducted with both chicks and laying hens.

Effect of Fertilization on the Vitamin A and C Content of Asparagus. (C. R. Fellers, R. E. Young, and J. A. Clague.) Two crops of asparagus grown at the Waltham Field Station have now been assayed for vitamins A and C. While it is evident that fertilization has no major effect on the vitamin C content of asparagus, the results show a slight depressing effect due to high potassium and a moderate increase due to high nitrogen fertilization. No significant effect on vitamin A was found.

Canned asparagus retained fully the original vitamin A content, but lost from 60 to 80 per cent of the vitamin C. On the other hand, quick-frozen asparagus showed no vitamin losses after storage for several months. The results are now being prepared for publication.

Oven Canning. (W. W. Chenoweth, C. R. Fellers, and Pearl Haddock.) The use of electric and gas ovens for canning fruits, vegetables, and meats has been extensively advocated by range manufacturers and public utility representatives. Experimental results on a variety of foods, including a careful study of heat transfer in ovens and in jars of foods in the ovens, showed that a temperature of 212° to 213° F. is never exceeded. Oven canning is considered less likely to prevent spoilage in canned non-acid vegetables, meats, and marine products than the pressure-cooker or water-bath methods. Loss of liquid in the jars and scorching at the top and sides are two undesirable factors. The work is being continued.

Maple Products. (C. R. Fellers.) Molds may cause maple sugar to become soft and semi-liquid. The action was traced to the liberation of invertase by the mold mycelium. The invertase acts on the maple sugar (sucrose) and causes inversion. Losses due to this type of spoilage are very large, and no previous explanation was found in the literature. The degree of mold infection may be readily determined by making a direct microscopic Howard count of the maple sugar. This should be of great assistance to buyers of maple sugar in determining keeping quality of sugar and its suitability for syrup manufacture.

Two seasons' work have been completed on vitamin A and C determinations on maple sap, syrup, and sugar. Neither vitamin was present in significant amounts.

DEPARTMENT OF OLERICULTURE

Ralph A. Van Meter in Charge

Asparagus Investigations. (Robert E. Young, Waltham.)

Fertilizers. The yields of the asparagus fertilizer plots show an average increase of about 45 per cent over the yields of last year, with a much greater increase at Waltham and Concord than at Eastham. The quality of asparagus on all plots was higher than last year. In general the results obtained were about the same as last year.

In Waltham the most outstanding result was the increase in yield due to

applying the fertilizer May 1 instead of June 20, the usual time. The plots receiving just the nitrogen in May did not give this increase. Nitrate of potash and sulfate of potash did not produce as large yields as did muriate of potash. The kind and amount of nitrogen applied seem to have had very little effect upon the yield, except that cottonseed meal gave a considerable increase in yield both this year and last. The increase in yield due to increasing the amount of potash has been in direct ratio to the amount of potash applied. The application of a fertilizer mixture containing 18 per cent potash increased the yield, as compared with the crop produced with a fertilizer containing no potash, sufficiently to pay for the potash and allow a profit of approximately \$30 per acre. The addition of extra phosphorus also gave a significant increase in yield.

The results at Concord were about the same as at Waltham, except that sulfate of ammonia caused a marked reduction in yield at Concord, while both cottonseed meal and a combination of guano and goat manure gave a great increase in yield.

The plots at Eastham still show the effect of organic matter, in the form of a crop of carrots turned under on half the field before the asparagus was planted. As a result, there is quite a variation between duplicate plots with the same treatment. The plots that have received no lime have been very materially reduced in yield. The plot receiving seaweed and superphosphate remains one of the high producing plots.

Varietal Improvement. Individual yield records were taken on 290 asparagus plant selections made by my predecessor. The number of stalks varied from 1 to 27 per plant, with a mean yield of 7.5 stalks. These records will be continued to determine the high yielding plants, which will then be removed to a seed production bed.

Effect of Fertilizers on Asparagus Plants Grown from Seed. The application of fertilizers to the seedbed in which asparagus seed was planted did not seem to have a harmful effect upon the asparagus plants. It was observed that there was a slight depressing effect when one of the fertilizer elements was either left out entirely or was present in extremely high amounts. This is the result for one year, and the experiment is being repeated.

Depth of Planting and Height of Cutting. A study of the yield records of this experiment shows that the plants have not yet reached their maximum production. The increase in productivity over 1931 was as follows:

	Per cent
Cut with only 4 inches green	44
Cut with 8 inches green	27.8
Cut with 12 inches green	29

The effect of the depth of planting remains about the same as last year. The deeper the roots are planted, the greater the mortality, which ranged from 11 per cent loss for the roots 2 inches deep to 31 per cent loss for the roots planted 8 inches deep.

Seed Improvement. (Robert E. Young, Waltham.) Samples of seed of the best strains of Horticultural bean grown in 1932 were distributed to a few selected growers this past season in order to determine the behavior of the beans when grown on different types of soil. The reports from these growers are very encouraging. Although selection will be continued, the seed stock now on hand

will be planted next year so that there may be a limited amount of seed available for 1935 plantings. It was observed that the seed stock was contaminated with some bacterial blight. Those who planted early reported some disease, while those who planted late, so that the plants matured in the cool fall, had no disease.

Considerable progress has been made in the improvement of the Waltham Beauty pepper. The plants are now more uniform in height, and the shape of the fruit is much improved. Performance on various types of soil was determined by placing samples of seed among the local growers. In general, the reports from these growers tend to indicate that it is better than any commercial strain available, although on several farms it has been observed that the pepper is not suited for light, high land where water is a limiting factor. Under these conditions the plants produced are very small and the yield small. Yield trials conducted at the Field Station this past season indicate that the Waltham Beauty will out-yield the California Wonder by 138 bushels per acre; Harris Earliest by 293 bushels per acre; and World Beater by 99 bushels per acre.

Strains of Blue Hubbard squash now in the third and fourth generation were grown, and selfed specimens obtained. There is still some variation in the strain, indicating that it is not yet pure. Difficulty was experienced in getting some of the strains which had been selfed three or four times to set fruit, while commercial strains growing alongside selfed easily.

Selections of the Field Station Comet tomato grown in the field last season proved to be somewhat better than the former strain. This variety of tomato is being grown both in the greenhouse and on trellis in the field. Selections are being continued to free the strain of some recent outcrops of mosaic. The Boston Market Gardeners Association has produced a considerable quantity of seed from foundation stock supplied by the Field Station.

Past work on the Field Station Hutchinson carrot has been aimed mostly at uniformity and proper size, very little consideration being given to color. Selections are now in the greenhouse where it is planned to cross the strain with one having a deep orange color. The popularity of this variety is attested by the fact that the local Market Gardeners Association has had 1500 pounds of carrot seed grown for them from stock seed supplied by the Field Station.

Selection of the Wyman-Crosby beet is being continued to obtain greater uniformity, earliness, and better color. The present strain is fairly uniform and medium early, but rather poor in color. Attempts are being made to obtain a beet with smaller top and better internal color.

Selections were made of Bel-May lettuce that was planted in the greenhouse, to improve the bottom of the lettuce head. Many plants are inclined to be rather open, which shows the lettuce at a disadvantage as it is customary to market it with the bottom of the head up. Plants are now being grown from selections seeded last spring. An ample supply of Bel-May seed is available through a local farmers' organization.

Selections of Pascal celery that were seeded in the greenhouse in 1932 were grown this year and proved to be quite an improvement over the original commercial strain. Celery that is more uniform in height and has a long petiole is the type that is desired. Selections will be continued in connection with a celery storage project that is now under way.

DEPARTMENT OF PLANT AND ANIMAL CHEMISTRY

Edw. B. Holland in Charge

The Effect of Fertilizer and Cultural Treatment on the Composition of Havana Tobacco. (E. B. Holland and E. Bennett.) During the past five years numerous samples of different grades of cured and sweat leaf from the station plots have been analyzed and the data are being compiled for publication. The results indicate a distinct increase in nitrogenous compounds and decrease in ash of the web from the base of the plant upward, a noticeable effect of different amounts of applied nitrogen, and seasonal influences difficult to explain. The trend in other plant constituents—fat, fiber, and nitrogen-free extract compounds—in the grades is not as apparent.

Supplementary work on popular brands of smoking tobacco and of cigarettes has also been continued. A study of seasonal influences on the yield and percentage of the more remunerative grades has shown a distinct correlation for seven years with five cropping systems, but additional seasons will be necessary for confirmation.

Oil Sprays. (E. B. Holland.) Miscibles were prepared from special lubricating oils of three different manufacturers, with triethanolamine and oleic acid as the emulsifying agent. These oils had a Saybolt viscosity of about 100 but varied appreciably in density and percentage of unsulfonated residue. The main objective this season was to determine whether oils of somewhat higher content of unsaturated hydrocarbons would prove toxic to the fruit trees. The miscibles were applied at concentrations of 2 and 3 per cent of lubricating oils by weight and no ill effects were observed, but the infestation of European red mite was too slight to afford much evidence on control.

The number of emulsifying agents on the market is increasing rapidly and one commercial "base oil" mixed with three parts of spindle oil was tested in 2 and 3 per cent concentrations with satisfactory results. The use of such products makes the preparation of a miscible a relatively simple matter for any fruit producer.

Cooperative Investigations. (E. B. Holland.) An investigation of the causes and prevention of injury to greenhouse cucumber plants from spraying with various copper fungicides followed by hydrocyanic acid gas has been concluded and prepared for publication. The work was conducted by E. F. Guba at the Waltham Field Station.

A study of the effect of "dark center" on the composition of turnips has been reported. The initial changes are characterized by a substantial loss of sugars with an increase in protein, fiber, and ash. These analyses supplement the work of G. B. Snyder and R. W. Donaldson relative to the control of the disorder.

A large amount of analytical work was expended on ice cream stabilizers in connection with problems of the Dairy Department.

Nitrogen Fixation in the Presence of or as a Result of the Growth of Legumes versus Non-Legumes Under Certain Defined Agronomic Conditions. (F. W. Morse.) The comparison of legumes with non-legumes was continued this year with alfalfa and barley. To prevent weeds overtopping alfalfa, the field was repeatedly harrowed up to July 20. On August 5 the field was sown with alfalfa and barley. The latter was at its full height October 10. A severe frost on October 25 stopped all further growth, and three days later the plants with nitrogen fertilizers were prostrate while those without it remained erect.

Synthetic nitrogen chemicals were substituted this season for the older forms and included calcium nitrate, leunaphos, and calurea. Barley on leunaphos was perceptibly the tallest. Alfalfa was plainly superior on the nitrogen fertilizers in comparison with the growth without them. Both alfalfa and barley were left uncut and the latter will be plowed under next spring.

The investigation now becomes a comparison of methods of synthesizing atmospheric nitrogen: soil organisms versus factory.

Some study has been made of the relations between rainfall and crop production during the years of this investigation. Especially marked is the difference between millets and soybeans in the ratio of dry matter to rainfall. Japanese barnyard millet and soybeans were both grown in 1926. The Japanese millet was again grown in 1930. Hungarian millet and soybeans were grown in 1932. The soybeans in 1926 reached the pod stage, but in 1932 were barely at the flowering stage.

Rainfall used in the calculations is limited to the period in which the crops occupied the land and may be considered as equivalent to irrigation, although irregularly distributed. The soil is practically saturated at the end of March. The rainfall during April and May was 4.81 inches in 1926, 4.75 inches in 1930, and 4.00 inches in 1932.

Dry Matter per Acre and Rainfall in Inches

Year	Crop	Date Sown	Date Harvested	Dry Matter Pounds	Rainfall Inches	Pounds per Inch
1926	Japanese millet	6/11	9/1	9195	9.24	995
1930	Japanese millet	6/12	8/7 to 21	7033	10.42	675
1932	Hungarian millet	6/1	8/12 and 15	5384	7.88	683
1926	Soybeans	5/25	9/17	3681	10.74	342
1932	Soybeans	6/1	8/12 and 15	4376	7.88	555

The weather records of the experiment station give the normal rainfall for April and May to be 6.90 inches and for June, July, and August, 12.11 inches.

Hungarian millet is a smaller variety than the Japanese barnyard millet, but in the somewhat dry season of 1932 it utilized the water as efficiently as the Japanese variety did in 1930.

The heavier rainfall in 1930 included two unusually severe showers in July that flattened the crop and hindered its subsequent growth.

Chemical Study of Cranberries. (F. W. Morse.) The study of quinic acid has been continued with the object of more accurately measuring the quantity present in the cranberry. A review of the cranberry investigations conducted by the experiment station was prepared, covering a period of 25 years.

A Study of the Availability of Soil Potash with the Object of Developing a System of Diagnosis for the Soils of the State. (F. W. Morse.) The soil surveys of this State having been completed and published by the United States Department of Agriculture, this project is now being closed with the completion of potash determinations in typical soils of some of the more widely distributed series. The availability of the soil potash must in general depend on the fineness of the soil particles exposed to the solvent action of the soil water. Potash minerals form the softer constituents of the principal rocks of the State, and were more finely ground by glacial action than the harder quartz. The clay and silt of the soils might be expected to contain a higher percentage of potash than would be found in the sands. In a large majority of the samples this has been found to be the case.

Ten representative soils contained an average of 75.4 per cent fine sands and 12.9 per cent silt-clay particles. The average percentages of potash were 1.71 in the sands and 2.08 in the silt-clay. The bulk of the soil potash is held in the sands. In 100 pounds of soil, the sands will contain 1.27 pounds potash and the silt-clay only .27 pound. But this average soil to the depth of six inches would contain about 4000 pounds per acre of potash in the silt-clay particles. The stronger loams of the State may need little potash.

Mineral Requirements for the Growth of Dairy Heifers. (J. G. Archibald and E. Bennett.) The second phase of this project involving a three-year study of phosphorus requirements has been completed and the results prepared for publication. The principal conclusion reached is that rations ordinarily fed to growing heifers often do not contain sufficient phosphorus for optimum growth.

Studies in the Chemistry of Pasture Grasses. (J. G. Archibald and E. Bennett.) Results of a survey of natural pastures in the five western counties of the State have been published in Bulletin 300.

Another year's data on the chemical composition of various species of grass have been secured. The analytical work on this season's samples is nearing completion and results for the three-year period will be ready for publication early in 1934. A second series of plots of single species of grass has been established this season on an entirely different type of soil and will be available for continuance of the study next season. The object of this second series is to ascertain, if possible, whether traits of chemical composition which have been characteristic of certain species thus far in the investigation will hold true on widely differing soil types.

Commencing next season the first series of plots will be used for investigation of the effect of fertilizers on the chemical composition of individual species. Thus far the grasses on these have been grown without the aid of fertilizer other than that residual in the soil.

DEPARTMENT OF POMOLOGY

F. C. Sears in Charge

The larger peach orchard of the Experiment Station was removed in the spring of 1933 and only a few trees in a variety block remain. The past winter was rather severe and fruit buds were badly killed on trees in sites subject to low temperatures.

The apple crop was large when one considers the rather heavy crop of 1932. This may be due to exceptionally favorable weather during and immediately following the blooming period. Air temperatures were unusually high and fair weather favorable to bee activity prevailed. These conditions were similar to those of 1930 when there was a very heavy crop.

The Interrelation of Stock and Scion in Apples. (J. K. Shaw.) Control of the main orchard was resumed by the Station after a year of operation by a private grower. These trees have not been doing well and crops have been small. Increasing the supply of nitrogen seemed to injure rather than to improve the condition of the trees. There was an apparent improvement in growth and appearance of the trees in two rows to which about 3 to 4 pounds per tree of muriate of potash was applied. Analysis of the ash from shoots of the present

summer's growth showed, in all cases, a distinctly higher potash content. These were the same two rows which received potash in 1931 with no apparent beneficial results. However, the potash was applied in that year to the freshly plowed surface, while in 1933 it was applied to the unplowed surface and harrowed in. These results suggest that in the former case the potash was fixed in the soil before the tree roots could take it up. These observations suggest that the leaf burn and general poor condition of the trees in this orchard may be due to lack of potash in the soil. The matter will be further investigated.

The younger orchard on Malling stocks continued to develop well. The yield of McIntosh and Wealthy on the more distinctly dwarfing stocks was small except for those on Stock 4, the Dutch Doucin. This may be due to injury to the root system from soil freezing during the winter. The root systems of these stocks is small and the anchorage of the stocks is not strong enough to prevent heaving. Trees on Dutch Doucin yield more than those on any other stock. There are at least two weaknesses of this stock: it is not as hardy to cold as may be desired, and the anchorage is not very good. The trees have thus far stood up well but they are located where they are not exposed to severe winds. This orchard was fertilized this year with calcium cyanamid applied about two weeks before bud break with good results.

Efforts to increase the supply of the Malling stocks were continued. A stock bed of about 1300 plants was established and about 1500 rooted layers were budded or are available for budding next spring. The supply of dwarfing stock in this country is very limited and efforts are planned to determine which of these dwarfing stocks are most desirable and to place them in the hands of nurserymen and stock growers.

Tree Characters of Fruit Varieties. (J. K. Shaw and A. P. French.) Efforts were continued to establish a nursery of cherry varieties with rather poor success. For some reason buds fail to take well on Mahaleb or Japanese flowering cherry stocks. This difficulty will have to be studied and overcome before variety studies can be made. It is felt that climatic or weather conditions here are not favorable.

Some further observations made in nurseries in connection with the usual certification work of the Massachusetts Fruit Growers Association's inspections of nurseries for trueness-to-name over a period of years show that, while the number of misnamed trees has been reduced to a very small percentage, new mixtures appear occasionally. These are detected at once and do not become a continuing trouble as in earlier years. Fruit growers run distinctly less risk of getting misnamed trees if they buy from nurseries that have been inspected for trueness-to-name.

The Genetic Composition of Peaches. (J. S. Bailey and A. P. French.) Breeding work was continued in the spring of 1933 and a good crop of pits was obtained. About 300 seedling peaches resulting from the breeding work of 1931 were set out in two blocks. As a result of the 1932 breeding work there are 2415 trees in the nursery to be set in the orchard in the spring of 1934. From among the seedlings resulting from the breeding work of 1928 a few of the best were selected and propagated. There are 97 trees in the nursery propagated from 13 of these seedlings. Some of these will be set in the orchard in the spring of 1934 for trial.

The Gold Drop variety has reniform foliar glands which is supposed to be a homozygous gland condition. Among 954 seedlings of Gold Drop, selfed, there appeared 213 or 22.3 per cent having globose glands (the heterozygous condition)

and very sharply serrated, wavy leaves, a character usually associated with eglandular leaves. At present no data are available to explain this behavior.

Effect of Pruning Bearing Trees. (J. K. Shaw and O. C. Roberts.) The two projects formerly listed as dealing with pruning bearing trees may be considered as one. Yields are not often reduced by light pruning but they may be if pruning is severe. The average size of fruits is often a little larger on pruned trees than on unpruned ones. Color of certain red varieties is likely to be improved by pruning, but improvement in pest control is generally small or absent. In the 40-year-old orchard much work has been required during the past two years to cut out dead and dying wood. It thus appears that bearing trees must be pruned sooner or later, for dead branches furnish an opportunity for decay to enter and threaten the life of the tree. It must be as well or better to cut out weak, shaded wood before it dies. All the pickers agree that picking is more difficult on the unpruned trees.

Comparison of Cultivation and Sod in a Bearing Orchard. (J. K. Shaw.) The fertilizer treatment of this orchard was the same as in 1932. Two cultivated plots in this orchard which had had no fertilizer for twelve or more years received a complete fertilizer in 1932 and 1933. No significant increase in production appeared last year, but in 1933 these plots produced the largest crops since planting. The purpose has been to increase growth of cover crop and thus the organic matter in the soil. While the cover crops were somewhat better in 1933 there can be no great increase of organic matter yet. The fertilizer program will be continued to see if the complete fertilizer gives better results than are obtained on the plots receiving nitrogen only. The crop for the latter plots was small. The sod plot receiving nitrogen and potash showed for the first time an increased yield of Baldwins, while the superior yield of McIntosh was not maintained so well this year. Twigs of both Baldwin and McIntosh from this plot showed higher potash content than others from a similar plot fertilized with only nitrogen.

Results from this orchard under observation for twelve years suggest the inadequacy of both the sod-nitrogen program and continued cultivation with a cover crop sown in early July.

The plot in cultivation without fertilizer continued to give low yields though they have been larger than they were in the earlier years, probably due to increased size of the trees.

Comparison of Clover Sod and Grass in a Sod Mulch Orchard. (J. K. Shaw.) The effort to maintain a sod of white clover by fertilizing with potash, phosphorus, and lime has proved a failure in this orchard. For the past three years the grass has been allowed to grow all summer partly to avoid the expense of mowing and partly to see what would be the effect on the trees. This may have been the reason for the disappearance of white clover. There does not seem to be any marked injury to the trees but, as no direct comparisons can be made, it cannot be said that no harm has resulted.

These white clover plots were given an application of a complete fertilizer in 1933 the same as the other plots. This seems to have increased the production from these plots, while that from the plots which have had a complete fertilizer for the past 11 years was smaller than previously. This experiment will be redirected next year.

Tests of Different Amounts of Nitrate of Soda. (J. K. Shaw.) Following the revised plan of using a complete fertilizer with 10, 17½, and 25 pounds of

nitrate of soda per tree in the off-bearing year only, these trees were fertilized in 1933. The crop was larger than in 1931 but the lower yield in 1932, the on year, reduces the two-year average for 1932-1933 below that of the previous two-year period of 1930-1931. This may be because of the remarkably large crop of 1930. No marked improvement of color and quality has been noticed. The present fertilizer plan will be continued.

Comparison of Cultivation and Heavy Mulching for Apples. (J. K. Shaw.) The mulched plots have been continued as before with additional mulch as available. Enough has been applied to suppress most of the grass and weeds. The cultivated plots received 300 pounds of nitrate of soda per acre. The Wealthy trees on Doucin stocks were removed in the spring of 1933 leaving only the standard trees. The Doucin roots sprouted freely and they seem to be Malling No. 6, Rivers Nonsuch Paradise. Yields of both McIntosh and Wealthy were somewhat smaller than in 1931, the previous light-bearing year.

The Effects of Fertilizer Limitation on Fruit Plants. (J. K. Shaw.) Lime at the rate of about two tons per acre was applied to the limed ends of the plots. This raised the pH value of the soil to about 6.25, where it was while the previous crop of trees was grown. The acidity of the unlimed plots remains about as it has been in earlier years, a little below pH 5. In all cases where potash is used alone or in combination, the growth of the trees was greater on the limed plots; while the reverse was true on all other plots except on one of the unfertilized plots. Growth was nearly twice as large on the unlimed plots receiving nitrate of soda but no potash, as on the unlimed plots with the same fertilizer. The results are similar to those with the previous crop of trees planted about 1922 except the trees on the phosphorus-potash-lime plots, where the growth is less than with those on the limed, complete fertilizer plots. It seems clear that a combination of potash and lime is the only fertilizer to which fruit plants respond on this soil, which has had a fixed fertilizer treatment for over 40 years. When potash and lime are applied, it may be that the addition of nitrogen will give further improvement in growth.

Role of Potash and Lime in Fruit Tree Nutrition. (J. K. Shaw.) Owing to limited funds and man power this project was dormant during the past year. It will be resumed or terminated and the results published in the near future.

Effect of Potash and Lime on Apple Trees. (J. K. Shaw.) The filler trees of several varieties were removed in the spring of 1933 (except the McIntosh trees) leaving only the Wealthy trees. There appears to be no effect from the lime, but the trees receiving potash in addition to nitrogen gave much larger yields than those receiving nitrogen only. The twigs from the potash trees contained more potash than those not fertilized with potash. If this trend continues in future years we must conclude that the time has come when this orchard requires potash in addition to nitrogen. There is as yet no indication of any benefit from additions of phosphorus to the fertilizer applied. This orchard is in sod.

Study of Varieties of Tree Fruits. (J. K. Shaw and O. C. Roberts.) Observations on numerous new varieties of different fruits were continued. Results were similar to those given in the last report. Wright's Early plum seems to be a promising substitute for Red June. It is equally productive and far better in quality.

Several new varieties of apples from C. P. Close of the United States Department of Agriculture fruited for the first time. They are all early red apples of

about the season of Yellow Transparent, some a little earlier and some a little later. Several of them are very promising, and buds of the better one were set to grow trees for a more extended trial.

Fruit Bud Formation in the Strawberry. (R. A. Van Meter.) This project is concerned with the effect, on fruit bud formation, of nitrogen applications at various times during the latter part of the growing season. The project was undertaken five years ago and changes have consisted chiefly in altering the planting plan to vary the number of plants per square foot.

No consistent effect on fruit bud formation has been found either when plants were grown in hills with ample room or in moderately filled matted rows; and no effect has been found either on a good strawberry soil or on a soil needing fertilization to grow grain crops satisfactorily.

A new bed was set in the spring of 1933 to note the effect on runner plants of varying ages. All plots are duplicated five times and all receive phosphorus and potassium.

Bud Mutation. (J. K. Shaw and W. H. Thies.) The collection of trees top-worked to various mutating strains of several varieties of apples was maintained but none have borne fruit. The "flat limbed" strain of Gravenstein apple has thus far produced only normal branches.

Storage of Apples Under Various Conditions. (O. C. Roberts cooperating with C. I. Gunness and W. R. Cole.) Two particular lines of investigation pertaining to the storage of apples have been undertaken as follows:

1. A study of the effect of humidity on the keeping quality of McIntosh and Baldwin apples at 32° and 45° F. This is a repetition of similar studies which have been carried on for two seasons previously. Indications suggest that a humidity of 80 to 85 per cent is adequate for the keeping of apples in cold storage, while 85 to 90 per cent is necessary in the air-cooled storage.

2. The storage of McIntosh apples above 32° F. It is a generally accepted fact that apples which are to be preserved in the fresh state for the maximum length of time should be placed in storage at 32° as soon as harvested and held at that temperature continuously throughout the storage life of the apples. At harvesting time the apples do not possess the quality and flavor which they later acquire if held at a temperature of 45° to 50°. A temperature of 32° modifies the ripening process to the extent that the apples fail to develop the most desirable eating qualities and thus are still "green" in flavor when removed from storage and offered to the consumer. This is particularly true of the McIntosh.

For two seasons experiments have been conducted to determine whether McIntosh apples can be kept satisfactorily by holding at temperatures of 40° to 50° for a period of two weeks and then decreasing the temperature until 32° is finally reached about the middle of November. These experiments have not been repeated a sufficient number of times to justify definite conclusions. However, present indications suggest that the following results may be expected:

- (1) The flavor of the apples is decidedly improved.
- (2) The apples can be held in good condition for the Christmas trade.
- (3) If apples are to be held for a longer period, they should be stored at 32° continuously.

Tests of Various Spray Materials. (O. C. Roberts, cooperating with A. I. Bourne and O. C. Boyd.) Various spray materials, both insecticides and fungicides, have been tested in the field to determine their efficiency and safety to

the tree and fruit. Results for the past season will be found in the report of the Entomology Department.

Blueberry Culture. (J. S. Bailey.) In the spring of 1933 the plantation to be used for cultural studies was enlarged to about one-half acre. The observations on height of water table were continued. Propagation was continued to obtain more plants for experimental purposes. Birds took such a large portion of the crop that very few berries were harvested from the variety plantings.

In the spring of 1932 some cultural experiments were started using one-year-old blueberry plants in three-gallon earthenware crocks. By the middle of the summer of 1933 it was evident that the root systems of the plants were becoming crowded and therefore the experiment on these plants would have to be discontinued at the end of the season. This work indicated that under some conditions lime is not as toxic to blueberries as has been previously supposed.

Additional pot experiments were started in the spring of 1933. These pots were accidentally left out in a heavy rain for a short time. The soil in some of the pots became saturated with water and several plants died and several more were severely injured as a result of the wetting. The new growth that was produced on the injured plants had light yellow, unhealthy-looking leaves. This accident emphasises the importance of planting blueberries in a situation where the roots will not be in a water-logged soil during the growing season.

DEPARTMENT OF POULTRY HUSBANDRY

J. C. Graham in Charge

Broodiness in Poultry. (F. A. Hays.) Results in developing a non-broody and an intense broody line through nine generations from 1923 to 1931 have been published as Bulletin 301.

The present method of procedure in this project calls for the use of progeny-tested sires in the non-broody line together with aged females for breeding, to discover whether it is possible to completely eliminate broodiness. More data are also being collected on degree of broodiness together with a study of inherited factors concerned in degree of broodiness.

Breeding Poultry for Egg Production. (F. A. Hays and Ruby Sanborn.) The mean annual egg production of the last generation of birds was 238 eggs. The mortality in the laying houses was 19.34 per cent. This last generation was superior in egg production to any other generation produced, and the mortality rate was significantly lower than in the two preceding generations. Egg size is steadily increasing without reducing the number of eggs laid. Hatching dates were set three weeks earlier in 1933 in order to study the performance records of the birds when hatched earlier. Special attention is being given to the elimination of winter pause, also to the establishment of greater uniformity for clutch size and to increasing vigor as measured by mortality in families on the range and in the laying houses. An exhibition quality strain was introduced in 1929 which has been carried in part for exhibition quality and in part selected for characters affecting egg production.

Statistical Study of Heredity in Rhode Island Reds. (F. A. Hays and Ruby Sanborn.) Data have been prepared under this project and published as follows: "The Significance of Length of Biological Laying Year in Production Breeding," Bulletin 298; "Crossing Production and Exhibition Rhode Island Reds," *American*

Naturalist 67: 539-548, 1933; "Characteristics of Non-Broody and Intense Broody Lines of Rhode Island Reds," Bulletin 301.

A Genetic Study of Rhode Island Red Color. (F. A. Hays.) In 1929 a line of highest quality exhibition Rhode Island Reds was obtained. In 1930 a cross was made using an exhibition male on production-bred females from the station flock. In 1931 reciprocal crosses were made together with $F_1 \times F_1$ and $F_1 \times$ original parents. In 1932 the F_3 generation was produced and F_2 birds have been backcrossed to grandparental stock. Complete egg records have been kept on all females along with records of plumage color. The data are now being prepared for publication.

Determination of Genetic Laws Governing Results of Inbreeding. (F. A. Hays.) The fifth generation of inbred progeny was hatched in 1933 from the two remaining lines. Progeny have also been produced by crossing the two lines. Special attention is being given to the prepotency of inbred birds compared with the general flock bred for high fecundity.

Factors Affecting Egg Weight and Shell Character in Domestic Fowl. (F. A. Hays.) Three lines produced each year by females laying 52-, 57-, and 59-gram eggs, respectively, during December have been carried into the sixth generation. The last two generations (1932 and 1933) have come from females having the ability to lay 52-, 57-, and 59-gram eggs in November of the pullet year. Distinctive types of shell color and shell texture have appeared together with significant differences in egg weight when the three lines are reproduced year after year by mating the three lines of females to full brothers.

Rate of Feathering in Rhode Island Reds. (F. A. Hays.) Preliminary studies on rate of feathering in Rhode Island Red chicks were made in 1931, 1932, and 1933. In the spring of 1933, 3200 chicks were classified for feathering on the twelfth day and again at eight or nine weeks of age. Some evidence has been secured that autosomal genes may be concerned in rate of feathering in Rhode Island Reds along with a major sex-linked recessive for early feathering.

DEPARTMENT OF VETERINARY SCIENCE

J. B. Lentz in Charge

Poultry Disease Elimination Law. (H. Van Roekel, K. L. Bullis, O. S. Flint, D. M. Yegian, and Miriam K. Clarke.) During the 1932-33 pullorum disease testing season, 301,000 blood samples were tested by the macroscopic tube agglutination method. This number represented 300,714 chickens and 286 fowl other than chickens in 338 flocks. Among the samples from chickens, 0.47 per cent were positive, the lowest percentage ever attained in this State. All of the flocks in two counties were classified as negative. In nine of the thirteen counties less than 1 per cent of positive tests were recorded. The number of non-reacting flocks was 276, approximately 82 per cent of the total flocks tested. Of these, 145 flocks were 100 per cent tested. These represent 145,420 birds, 48 per cent of the total number of birds tested. No reactors were detected among the turkeys, pheasants, ducks, geese, and guinea fowl which were tested on 12 farms. Chickens were tested on 9 of these farms and revealed infection in 5. Necropsies were performed on 70 birds for 40 flock owners.

Pullorum Disease Investigations. (H. Van Roekel, K. L. Bullis, O. S. Flint, D. M. Yegian, and Miriam K. Clarke.)

1. *Cause of Doubtful Reactions.* These reactions occur in many birds from which *S. pullorum* cannot be isolated. Antigens were prepared from members of the typhoid, paratyphoid, and dysentery groups of bacteria. Agglutination tests were conducted with 11 species of these groups, employing 20 positive, 20 negative, and 39 doubtful pullorum sera. The positive and doubtful sera produced reactions in the majority of the antigens, while the negative sera reacted mainly with the dysentery antigens. Agglutinin absorption tests in a few sera also indicated that the dysentery group probably was not associated with the doubtful pullorum reactions. Thirty-three negative and ten doubtful sera were tested with 33 single strain antigens, representing 12 species of the three groups. Results of these tests were similar to the previous tests. Twenty birds were inoculated with 20 strains of 11 species, representing the three groups. Sera from these birds were tested with the 33 single strain antigens. The tests indicated that by employing ordinary laboratory cultures the agglutination relationships of *S. pullorum*, *S. gallinarum*, *S. abortivo-equina*, *S. enteritidis*, *S. aertrycke*, and *E. typhi* were so close that the sera could not be differentiated by the agglutination method alone. The *S. suispestifer*, *S. schotmulleri*, and *Al. fecalis* sera could be differentiated. The dysentery sera could be differentiated from all the others, and within the group the Sonne and Flexner types reacted differently. Considerable variation in agglutinability was noted within each species.

2. *Infectivity of Droppings.* Twenty-five hens, negative to the tube agglutination test, were exposed to litter contaminated with fresh droppings from positive hens. The exposure consisted of approximately one pint of fresh droppings six days a week for 52 weeks. Up to the present time, two months after the litter contaminations ceased, there have been no positive reactions.

3. *Viability of S. pullorum.* The organism has been recovered from a dry piece of cloth after a period of 503 days. Part of this was reported in a Master's thesis by M. K. C.

Laboratory Service--Pathology. (K. L. Bullis and D. M. Yegian.) Personal calls at the laboratory were recorded 107 times. The number of cases handled was 366 and the number of specimens 1,116. Distribution of the specimens was as follows:—1,041 chickens, 26 turkeys, 20 rabbits, 9 quail, 6 pheasants, 5 sheep, 2 grouse, 2 guinea pigs, and 1 each of the following:—canary, cow, dog, hay, and pigeon. The diseases encountered most frequently were parasitism, so-called "range paralysis," pullorum disease, and tumors. Disturbances of the kidney and oviduct were found in a large number of specimens. Several cases of entero-hepatitis in chickens were recorded. Diagnoses of diseases which are believed to be rare in Massachusetts were:—fowl typhoid 4, fowl cholera 2, and 1 each of avian tuberculosis, intestinal capillaria, erythroleukosis, feather mites, paratyphoid in turkeys, and gape worms in quail. A fatal case of corynebacterium infection was diagnosed in a pullet. A search of the literature did not reveal a description of this organism.

Farm and Station Bang Disease. In assisting this project, the laboratory tested 850 blood samples by the standard tube agglutination method.

Infectious Laryngotracheitis Field Experiments. (C. S. Gibbs.) Approximately 11,000 chickens were vaccinated against infectious laryngotracheitis during the summer of 1933 under range conditions. An especially virulent strain

of virus was used in preparing the vaccine. This virus had been studied in the laboratory several months and was maintained in one-month-old chickens, which had also been reared under laboratory conditions since they were two days old. The chickens for the laboratory studies were all secured from a single poultryman, and were uniform in size, appearance, and resistance. The virus was not used in the field experiments as vaccine, unless it killed one-month-old chickens in five days. This arbitrary standard was necessary because laboratory tests indicated that any attenuation in the virulence of the virus might produce unsatisfactory vaccine.

A special technique was devised for restraining the birds and making the inoculations. In the field experiments the percentage of takes varied from 80 to 100 per cent, depending upon the age of the birds. As far as takes were concerned the most satisfactory results were secured with chickens three and four months of age. This period correlated with the age of greatest susceptibility in chickens inoculated intratracheally with fresh virus.

Up to the present it has not been definitely proved whether this correlation is real or apparent. Anyway, it was found that the number of successful takes fell off proportionally as the chickens were older or younger than three and four months. These variations may have been due to the fact that natural resistance of chickens to vaccination increased with age, while difficulties in inoculating the bursa of Fabricius and the cloaca increased with the smallness in size.

The vaccinated birds are being checked for cloacal and laryngotracheal carriers. The results of this part of the experimental study will be reported later.

Distribution and Epizootiology Studies of Infectious Laryngotracheitis. (C. S. Gibbs.) This study is being conducted jointly by the Department of Veterinary Science and County Agents. The object is to make a thorough investigation of the distribution and epizootiology of infectious laryngotracheitis in Massachusetts. It is hoped that this study will eventually lead to some practical methods of controlling the disease. As yet the information which has come in is meager, although it is sufficient to indicate that the disease is confined largely to the eastern part of the State, and some counties have more of it than others. Factors other than chronic carriers seem to be instrumental in the spread of the disease from endemic centers. Just what these factors are in each locality has not yet been determined. It is impossible to formulate satisfactory control measures until these factors are known and other field studies completed.

Further Studies on the Desiccation and Preservation of Infectious Laryngotracheitis Virus. (C. S. Gibbs.) Recent experiments in this laboratory have shown that the virus of infectious laryngotracheitis may be satisfactorily desiccated and preserved by filling a properly prepared desiccator with dry air. The air is dried by passing over anhydrous calcium chloride, and through alkaline pyragallol and sulfuric acid. The dry air is drawn into the desiccator by means of an ordinary water pressure pump.

This method of desiccating and preserving infectious laryngotracheitis virus offers no advantage over the modified Swift method, which has been in use in this laboratory for several years, except that a vacuum pump is unnecessary, and the cost of equipment reduced.

Avian Paralysis or Neurolymphomatosis. (C. S. Gibbs.) An apparent relation of lymphocytoma to neurolymphomatosis has been demonstrated in a systematic study of malignant growths and paralytic conditions in a flock of known history. In some of the cases under study the pathological cell involved in

lymphocytoma apparently metastasized into the nervous system, and in other cases the metastasis extended in the opposite direction, i. e., from the nervous system into adjacent tissues. Concurrent affections were ruled out because the tumorous growths appeared to be continuous in these cases. In other cases lymphocytomas and neurolymphomas were found to be sharply separated by parenchymatous organs, muscles, and nervous tissue. The only possible explanation of these malignant growths concurrently invading all tissues of the fowl as single entities is that they are either lymphocytomas or neurolymphomas of such invasiveness that all tissues are affected by them. If this explanation is correct, then lymphocytoma and neurolymphomatosis have the same pathological characteristics when invading the same tissues; and it follows that neurolymphomatosis is a disease of young birds, while lymphocytoma is a manifestation of the same disease in older birds ten months or more of age. However, in spite of the conclusiveness of the evidence presented by these histological studies of spontaneous cases, the exact relation between lymphocytoma and neurolymphomatosis awaits etiological confirmation.

In these studies neurolymphomatosis was rarely found associated with a leukemic state of the blood, such as occurs in erythroleukosis and myelogenous leukemia. Lymphocytoma was more often complicated by leukemia.

Lymphocytoma, neurolymphomatosis, and leukemia are apparently responsible for an excessive mortality in flocks in which they exist, and are quite beyond the power of the average poultryman to control. The object of this study is to find some practical method of control. The results thus far indicate that all of them are probably of an infectious nature and poultrymen may be able to control them by slaughtering all birds showing symptoms. The diagnostic service is available to poultrymen for the purpose of assisting in the diagnosis of these diseases.

Sexing Living Baby Chicks. (C. S. Gibbs.) A demonstration of sexing living baby chicks was put on at the Poultry Breeders' School this year (1933). Considerable interest was shown and the method may find some practical use in New England. Schools are being established on the Pacific Coast and in the Middle West for the determination of sex in living baby chicks, and New England pountrymen may be forced to sex their chicks in the future in order to hold their trade. Furthermore, it should be remembered that over-production is one of the Nation's greatest problems. Drastic steps are being taken by the more progressive industries under the direction of the government for the curtailment of production of those commodities of which there is a surplus. Chick sexing immediately offers a method of reducing the cockerel surplus and lowering the cost of pullet production, as well as simplifying disease control problems due to overcrowding.

WALTHAM FIELD STATION

(Waltham, Massachusetts)

Ray M. Koon in Charge

For reports on approved projects conducted at this Station, in addition to those listed under this caption, see reports of the Departments of Botany, Entomology, Floriculture, and Olericulture.

Along with its function as a research unit of the College, this Station has continued to develop and advance in its usefulness as a center of information because

of its proximity to a dense population of varied horticultural interests. During the year there have been recorded more than 2500 persons who have consulted members of the staff regarding troubles threatening their commercial enterprises or to request assistance with problems relating to amateur horticulture as it is practiced by the home gardener. Telephone inquiries have numbered 2765, or 640 more than last year. The requests for printed information have increased in the same proportion.

Over 1000 soil samples have been brought to the Field Station during the year. Soil deficiency tests have been made and recommendations offered.

The Boston Market Gardeners Association has continued to use the Station as headquarters for their monthly Executive Committee conferences and have contributed much in the way of suggestions for worth-while projects. The Field Station staff has, as usual, arranged the program of seven educational meetings which the Market Gardeners Association holds during the winter months.

The Fifteenth Annual Field Day was held on August 2 with over 900 farmers attending. Demonstrations, most of the variety trials, and special projects were planned with this day in view. Continued interest was shown by the visitors in the work of the Field Station. Firms selling anything helpful to vegetable or flower growers were invited to demonstrate their wares, and twenty were represented.

The Seventh Annual Celery, Second Bunched Carrot, and First Bell Pepper Contests were held.

The Plant House. (P. W. Dempsey.) Interest in the model plant houses at the Field Station, and in the plans available for distribution, has been maintained at about the same level during the past few years. The new type of hot water heater, made by a national concern, installed in the new plant house last winter has proved extremely satisfactory. With automatic draft control, it is efficient in its use of fuel; with return opening only three inches from floor line, no pit is necessary; and the first cost is exceptionally low. Fuel costs for operating both plant houses (each 10 x 30 feet) all winter were about the same (\$75 each) in spite of considerable differences in the type of construction.

Electricity as a Source of Heat in the Hotbed and Propagating Bench. (P. W. Dempsey.) Interest in this project on the part of commercial growers seems to be almost at a standstill. This is primarily due to the natural hesitancy to adopt new methods and also to excessive operating costs in many parts of the State. Charges for current by different companies vary considerably, many asking a price that almost prohibits consideration of the use of electricity as a source of heat for these purposes. A few power companies are cooperating even to the extent of furnishing equipment and current for growers who are willing to experiment.

Results obtained at the Field Station in the benches and beds were similar to those of last year. These prove that the equipment is good and show that some practical uses for this ideal heat will be found before long.

Work will be continued especially along the line of propagating hardwood and softwood cuttings.

Vegetable Variety Trials. (P. W. Dempsey.) This year the sweet corn tests included over seventy strains. There was no outstanding strain or new variety of particular merit. Bacterial wilt attacked the trials for the first time and although all the varieties were affected the early maturing varieties which have received particular attention the past few years were especially diseased. The Spanish Gold variety was the only exception, showing considerable resistance.

The late maturing varieties were not affected seriously (most of them yielding 80 per cent or better), and the new hybrids and inbreds showed almost no indication of wilt. If the wilt increases in severity as it promises to, resistance will necessarily be an important factor in variety or strain selection in the future. Earliness and size of ear have held the stage for many years; the Golden Sunshine, Early Golden Market, Golden Gem, and other varieties have occupied the spotlight. Now it seems as though attention will be focused on top-crossed, hybrid, and inbred strains. Seedsmen and experiment station breeders have been producing superior crosses, especially for the canners, for several years. All of these have been late in maturing in the Field Station trials thus far. Now, however, it will be necessary to consider them and plans are under way for an extensive trial of all these new strains available in 1934.

Over a hundred strains of tomatoes were planted this year in the tomato trials. Interest in trellis tomatoes is exceptionally keen just now, so particular attention was paid to varieties for this purpose. Many crosses of the Comet variety, originally made by V. A. Tiedjens and carried on by R. E. Young, were included and showed considerable promise. Further crosses made by Young also show possibilities; one, especially, of the so-called Field Station Comet on Lloyd Forcing was particularly good. Most of the strains for staking, procured directly from commercial seedsmen, were not satisfactory. There was no outstanding variety or strain in the trials except those referred to of the Field Station Comet crosses.

As in the case of the sweet corn crop, the tomato crop of Massachusetts is also threatened by a serious disease, the late blight rot (*Phytophthora infestans*). This disease was reported as present in this State in 1905. From that time until 1932 no mention of it can be found in State records. Last year about 10 per cent of the tomato crop was affected, the disease causing trouble mainly on the late outdoor crop and greenhouse crop after September 5. In 1933 over nine-tenths of the crop was affected, many complaints being received as early as the middle of August. There seems to be little or no difference in the susceptibility of different varieties to the disease, the only means of prevention probably being thorough spraying or dusting with Bordeaux.

The Model Vegetable Garden. (P. W. Dempsey.) A vegetable garden 50 x 100 feet that would serve as a possible stimulus and model to visitors was started this year. Many and varied are the plans given in extension circulars and seed catalogs, but a close perusal will show discrepancies in dates, distances, and other factors. This garden was planted to obtain definite information under average conditions. No manure was used; the whole garden was plowed, harrowed, and fertilized at one time; possible succession crops were emphasized especially. Flowers were included to increase the interest of all members of the family. Seed was planted by hand. Rake and hoe were the only tools used. This demonstration will be repeated and records will be kept of the various costs.

Varieties of Small Fruits. (P. W. Dempsey.) So many inquiries have come to the Field Station concerning the culture and varieties of small fruits that it was thought worth while to start a small-fruit test plot in order to permit visitors to observe a few of the standard varieties and some of the promising new varieties under actual cultivation. A number of raspberry and strawberry varieties were set last spring as a beginning.

Control of Cabbage Maggot. (W. D. Whitcomb and H. A. Wilson.) To determine the number and time of applications of a 1-1000 solution of corrosive sublimate which is most economical and effective in controlling the cabbage

maggot, treatments were made at the rate of $\frac{1}{2}$ cupful per plant on May 9 (when the first cabbage maggot eggs were found), May 16, May 23, and May 30. Fourteen plots were arranged so that all of the possible combinations from four applications were made. In the untreated plot 57 per cent of the plants were damaged by the maggot.

One application made on May 9 gave 98 per cent control and made on May 16 94 per cent control, but the latter plot yielded twice as many large or medium sized heads and seems preferable. Two applications gave perfect control except when the first application was delayed until May 23. The number of good sized heads was greater when the applications were made on May 9 and May 16, and these appear to be the most timely applications. Three and four applications also gave perfect control, but the yield was not sufficiently greater than where two applications were made, to warrant the additional labor and cost. In this planting, about 75 per cent of the plants yielded large or medium sized heads by June 26 if the maggot was satisfactorily controlled.

Three applications of dusts containing mercury also gave 98 to 100 per cent control when applied on May 9, 16, and 23. Applications from both sides of the row did not increase maggot control over application from one side, but the size of the heads was improved by the additional dust. Two commercial dusts containing derris or rotenone did not give satisfactory control of maggot, and tar paper discs were not satisfactory.

Ornamental Display and Test Gardens. (Harold E. White.) The ornamental display gardens were established at the Field Station in 1931 to permit the study of varietal reactions and to provide an opportunity for the public to observe the plants they may desire to grow commercially or with which to beautify their home environment. The response of the public to these gardens has far exceeded expectations. At present, the gardens contain approximately 100 varieties of iris, 80 varieties of peonies, 40 varieties of roses, 40 varieties of New England asters, 500 varieties of rockery plants, 400 varieties of miscellaneous perennials, and 50 varieties of shrubs. All this plant material has been supplied gratis and with eagerness by various nurserymen. In addition, the New England Gladiolus Society maintains a display plot of some 300 varieties of gladiolus. Each year, fifteen to twenty seedsmen supply seeds of the new introductions in annual flowers in return for which they receive a report as to the quality of these varieties. Future reports will be in the nature of observations on hardiness and habits of certain ornamentals.

Horticultural Schools. (Harold E. White.) These schools originated in 1931 for the purpose of providing florists with the latest cultural information derived particularly from research, and to offer a source of information for home gardeners who, because of necessity or preference, do their own gardening. The Florists Schools have been attended each year by between 200 and 300 florists. The first Home Gardeners School in 1931 for one day drew 700 persons which was a far greater number than could be adequately accommodated. In 1932 and 1933 the two-day Home Gardeners program attracted an attendance of 800. A considerable number attending have come from outside this State. Schools of this nature have now become a part of the regular activity of the leading colleges.

PUBLICATIONS

Bulletins

- 293 Annual Report for the Fiscal Year Ending November 30, 1932. 68 pp. March, 1933.

The main purpose of this report is to provide an opportunity for presenting in published form, recent results from experimentation in fields or on projects where progress has not been such as to justify the general and definite conclusions necessary to meet the requirements of bulletin or journal.

- 294 Recreational and Forestry Uses of Land in Massachusetts. David Rozman. 20 pp. illus. January, 1933.

During the last few decades there has been a considerable decline in the land area under cultivation in the State of Massachusetts; and largely as a result of this abandonment of farm land, about one third of the total area in towns with a population of less than 10,000 is owned by non-residents. In towns situated on the Coast and in some inland towns, especially in Berkshire County, such land is utilized to a great extent for recreational purposes; but in most other areas, land owned by non-residents is represented by idle acres covered by brush and inferior woods. The development of recreational uses in communities with a large area of idle land benefits the local population by providing a greater amount in tax receipts, a local market for agricultural products, and some employment for local people; yet in some cases lack of interest in local institutions and competition with the farmers for hired labor may be detrimental. However, even with the increase in recreational uses and part-time farming which may be expected with the increase in good roads, the greater part of this idle land will have to be used for the growth of trees. Already there is a considerable area in state and town forests and small areas held by various public organizations. Care should be taken in increasing these holdings to see that the areas taken are not likely to be needed for other developments, such as part-time farming and summer homes.

- 295 The Immunology of Infectious Laryngotracheitis. Charles S. Gibbs. 20 pp. illus. May, 1933.

In order to be acceptable to the majority of poultrymen, treatments for infectious laryngotracheitis must be cheap, easy to administer, and fairly effective. Intravenous and subcutaneous methods of stimulating immunity did not measure up to this standard, and are therefore not recommended for field practice. Under laboratory conditions, the inoculation of the bursa of Fabricius appears to be the most satisfactory method of immunizing birds against this disease. Only birds in the best of health are suitable for vaccination, which is best administered when the birds are between three and four months old. Carefully controlled experiments are needed to determine the practical value of this method of vaccination under range conditions as well as the duration of immunity in fowls in heavy production.

- 296 Effect of Manufacturing and Preserving Processes on the Vitamins of Cranberries. Paul D. Isham and Carl R. Fellers. 19 pp. illus. May, 1933.

Cranberries are an important crop in Massachusetts. Nearly all of them are processed in some way before they are consumed. This study was undertaken to determine the effect of various methods of processing on their nutritive value. Both fresh and frozen cranberries are a very good source of vitamin C, the minimum protective dose for young guinea pigs being 3.5 to 4.5 grams daily. Whole-fruit cranberry sauce retains approximately three fourths of the vitamin C of the fresh fruit; but strained sauce, evaporated cranberries, and cranberry juice are poor sources of this vitamin. A four months' storage period at 40° F. caused a loss of 20 per cent in vitamin C content. There is a small but definite amount of vitamin A in cranberries; but vitamins B, D, and G are either absent or present only in traces. The study showed that handling and manufacturing methods may greatly alter the nutritive value of cranberries and cranberry products.

- 297 The Effect of Certain Cropping Systems on the Yield and Quality of Havana Tobacco. A. B. Beaumont, M. E. Snell, and E. B. Holland. 28 pp. illus. June, 1933.

Several cropping systems for tobacco either used or suggested for the Connecticut Valley were compared and results for eight years, 1924-1931, are reported. These experiments present a rather convincing argument for the use of a moderate quantity of manure as a supplement to commercial fertilizer. The advantage from manure lies largely in its effect on quality. The use of red top cover comes second as a means of producing good quality of tobacco, and is a much more feasible cropping system for most Valley farmers on account of the scarcity of manure. The rotation experiments gave results which were quite unfavorable to tobacco, although in most cases the other crops were apparently benefited by having tobacco in the rotation. The cropping systems studied produced little or no change in the soil conditions. Continuous culture of tobacco without the plowing in of a cover crop caused the greatest increase in acidity, which was only 0.5 of a pH unit. The use of cover crops, the rotation, and manure tended to stabilize the reaction of the soil; and acidity was reduced only in one of the rotations where limestone was used.

- 298 The Significance of Length of Biological Laying Year in Production Breeding. F. A. Hays and Ruby Sanborn. 11 pp. illus. June, 1933.

High persistency has long been recognized as an important factor in breeding for egg production. In previous studies persistency has been considered only within the limits of the 365-day pullet laying year. In the study here reported, birds having the ability to lay continuously for more than 365 days were found to be superior for breeding purposes to those having a shorter laying year.

- 299 Shipping Massachusetts Apples to Out-of-State Markets. A. H. Lindsey and A. A. Brown. 27 pp. illus. October, 1933.

The development of apple orchards in New England and especially in Massachusetts has made it desirable for growers to find markets outside of the immediate production area. Information regarding transportation methods and costs was obtained from growers who have been shipping to New York markets. Transportation and terminal facilities are described for seven leading cities which might become profitable markets for Massachusetts apples, and the advantages and difficulties of each of them discussed.

- 300 Chemical Composition of Herbage from Massachusetts Pastures. J. G. Archibald and E. Bennett. 7 pp. October, 1933.

In general the herbage from pastures located on Becket loam and Stockbridge loam, two common soil types in Berkshire County, was superior to that from pastures in the counties farther east. It contained more protein and minerals and less fiber, and the quantity of grazing available was usually greater. All of the samples measured up quite well in protein content and were not unduly high in fiber; the amount of calcium ranged from fair to good; but there was quite a decided deficiency of phosphorus, particularly on the lighter, less drought-resistant soils and in the autumn samples.

- 301 Characteristics of Non-Broody and Intense Broody Lines of Rhode Island Reds. F. A. Hays. 12 pp. November, 1933.

Through the method of breeding followed, the percentage of non-broody individuals in the pullet year for the non-broody line has fluctuated rather widely from year to year, reaching a maximum of 92.31 per cent and a mean of 72.66 per cent for the nine-year period. For the broody line, the mean percentage of non-broody daughters was 20.46 per cent. The data show that degree of broodiness is inherited; also that the non-broody line was distinctly superior to the broody line from the standpoint of annual egg production.

- 302 Higher Aging Temperatures in the Manufacture of Ice Cream. W. S. Mueller and J. H. Frandsen. 16 pp. illus. November, 1933.

Aging at 68° F. for 2, 4, and 6 hours produced no measurable effect on bacterial growth, pH, or titratable acidity of a pasteurized ice cream mix. When an ice cream mix which contained the correct amount of gelatin for low temperature aging was aged for 4 hours at 68° F., excessive retardation of melting and a curdled appearance resulted. This objectionable melting condition can be corrected by reducing the gelatin content approximately one fourth.

- 303 Effect of Hydrocyanic Acid Gas on Cucumber Plants Previously Sprayed with Copper Fungicides. E. F. Guba and E. B. Holland. 16 pp. illus. December, 1933.

The control of fungous diseases and insect pests of cucumbers in greenhouses frequently requires the use of copper fungicides and hydrocyanic acid gas. Complete destruction of greenhouse cucumber plantings has occurred in Massachusetts in some instances from such treatment. The only copper sprays which did not cause injury when followed by hydrocyanic acid gas were commercial basic copper carbonates, basic copper sulfates, and non-staining ammoniacal copper sprays. If other copper fungicides are used, fumigation with hydrocyanic acid gas should precede the copper spray in order to avoid injury.

- 304 Secondary Milk Markets in Massachusetts in the Period of Falling Prices, 1930-1932. David Rozman. 20 pp. illus. December, 1933.

The bulletin deals with the analysis of marketing problems arising largely from changing conditions of the milk supply in secondary markets of Massachusetts, represented by Gardner, Attleboro, and Newburyport. The most disturbing factors for the maintenance of stability in the secondary markets were found to be the influx of outside milk and the increasing number of producers entering the distributing field. The attempt to maintain a stable price level in the small markets independently of the general market trend has generally met with little success. The average net price obtained by producers for their milk in the summer of 1932 was 4 1 cents per quart in Gardner, 6 cents in Attleboro, and 4.8 cents in Newburyport. The highest percentage spread between these and prevailing retail prices was in Gardner and the lowest in Newburyport. The milk marketing set-up prevailing in Newburyport, where most of the producers sell their milk to small dealers and distributors, largely their neighbors, was found to be the most economical for a small market.

Control Bulletins

- 67 Seed Inspection. F. A. McLaughlin and Margaret E. Nagle. 47 pp. February, 1933.
- 68 Thirteenth Annual Report on Eradication of Pullorum Disease in Massachusetts. The Poultry Disease Control Laboratory. 8 pp. August, 1933.
- 69 Inspection of Commercial Fertilizers. H. D. Haskins. 46 pp. November, 1933.
- 70 Inspection of Commercial Feedstuffs. Philip H. Smith. 58 pp. December, 1933.
- 71 Inspection of Agricultural Lime Products. H. D. Haskins. 8 pp. December, 1933.

Meteorological Reports

- 529-540, inclusive. Monthly reports giving daily weather records, together with monthly and annual summaries. C. I. Gunness. 4 pp. each.

Reports of Investigation in Journals

(Numbered Contributions¹)

- 138 Nutritive Value of Cranberries. Carl R. Fellers. Amer. Jour. Pub. Health 23:13-18. January, 1933.
- 140 Bronchitis in Baby Chicks. Charles S. Gibbs. Poultry Sci. 12:46-48. January, 1933.
- 141 The Desiccation and Preservation of Infectious Laryngotracheitis Virus. Charles S. Gibbs. Jour. Bact. 25:245-251. March, 1933.
- 142 The Distribution of Nitrogen in Tobacco When the Supplies of Nitrogen and of Light Are Varied During the Growing Period. Walter S. Eisenmenger. Jour. Agr. Research 46:255-265. February 1, 1933.
- 143 Some Factors Affecting the Palatability of Pasture Plants. A. B. Beaumont, R. E. Stitt, and R. S. Snell. Jour. Amer. Soc. Agron. 25:123-128. February, 1933.

- 145 Studies of Bacterium Coli in Privately Owned Rural Water Supplies. Ralph L. France. Jour. Bact. 25:623-635. June, 1933.
- 148 Studies in the Food Requirement of Adolescent Girls: IV. The Mineral Intake of 38 Well-Nourished Girls 10 to 16 Years of Age. Bernice Wait and Lydia J. Roberts. Jour. Amer. Dietet. Assoc. 9:124-137. July, 1933.
- 150 Relation Between Body Weight and Age at Sexual Maturity in Rhode Island Red Pullets. F. A. Hays. Poultry Sci. 12:23-25. January, 1933.
- 151 Relation of Weight at Sexual Maturity to Annual Egg Production. F. A. Hays. Poultry Sci. 12:25-26. January, 1933.
- 152 "Suspected Mosaic" of the Strawberry. E. F. Guba. Phytopath. 23: 654-661. August, 1933.
- 153 Vitamin C Content of Baldwin Apples and Apple Products. C. R. Fellers, M. M. Cleveland, and J. A. Clague. Jour. Agr. Research 46:1039-1045. June 1, 1933.
- 154 The Influence of Legume versus Non-Legume Crops on the Microbiological Activities in the Soil: II. Nitrification and Cellulose Decomposition. James E. Fuller. Soil Sci. 35:485-491. June, 1933.
- 155 The Proper Supplementary Ration for Milking Cows on Fertilized Pasture. Richard C. Foley. Jour. Dairy Sci. 16:407-411. September, 1933.
- 158 Aging Effects on Gelatin Dispersions. W. S. Mueller. Indus. and Engin. Chem. 25:707. June, 1933.
- 159 Relation of Temperature to the Development of the Plum Curculio in Apples. W. D. Whitcomb. Jour. Econ. Ent. 26:415-419. April, 1933.
- 160 The Massachusetts Plan for the Eradication and Control of Infectious Laryngotracheitis. Charles S. Gibbs. Jour. Amer. Vet. Med. Assoc. 83 (N. S. 36): 214-217. August, 1933.
- 161 The Inheritance of Certain Characters in the Peach. J. S. Bailey and A. P. French. Amer. Soc. Hort. Sci. Proc. 1932:127-130. 1933.
- 162 Vitamin C Distribution in Baldwin and McIntosh Apples. C. R. Fellers, P. D. Isham, and G. G. Smith. Amer. Soc. Hort. Sci. Proc. 1932:93-97. 1933.
- 163 Assimilation of Fixed Nitrogen by Grasses and Clovers. A. B. Beaumont, W. S. Eisenmenger, and W. J. Moore, Jr. Jour. Agr. Research 47:495-503. October 1, 1933.
- 164 Filtrable Virus Carriers. Charles S. Gibbs. Jour. Infect. Diseases 53:169-174. September-October, 1933.
- 165 Vitamins C and A in Blueberries. C. R. Fellers and P. D. Isham. Jour. Agr. Research 47:163-165. August 1, 1933.
- 166 Relation of Time of Laying and Embryonic Mortality. Costas Nicolaides. Poultry Sci. 12:274-276. July, 1933.
- 167 Time, Temperature and Humidity Relationships in the Pasteurization of Dates. J. A. Clague and C. R. Fellers. Arch. Mikrobiol. 4:419-426. 1933.
- 169 Vitamin C. Content of Strawberries and Strawberry Ice Cream. C. R. Fellers and M. J. Mack. Indus. and Engin. Chem. 25:1051-1052. September, 1933.
- 170 Crossing Production and Exhibition Rhode Island Reds. F. A. Hays. Amer. Nat. 67:539-548. November-December, 1933.
- 171 Effect of Cranberries on Urinary Acidity and Blood Alkali Reserve. C. R. Fellers, B. C. Redmon, and E. M. Parrott. Jour. Nutrition 6:455-463. September, 1933.

- 172 Using Plastic Cream as an Ingredient in the Manufacture of Ice Cream. C. R. Foskett and M. J. Mack. *Ice Cream Trade Jour.* 29, No. 9. September, 1933.
- 173 Studies on Melting Ice Cream. W. S. Mueller. *Ice Cream Trade Jour.* 29, No. 10. October, 1933.
- 174 Onion Powder: A New Use for Cull Onions. Carl R. Fellers. *Food Industries* 5:397-398. October, 1933.

¹Nos 147, 149, 156, 157 were cancelled; No. 168 has not yet been printed.

Other Contributions to Journals (Unnumbered)

- Some Important Carnation Troubles and Their Control. E. F. Guba. *Proc.* 42d Ann. Meeting, Amer. Carnation Soc. 1933:43-71.
- Some Old Notions Topple. Linus H. Jones. *Better Homes and Gardens* 11(6):27. February, 1933.
- Copper and Brass Plant Containers. Linus H. Jones. *Florists' Exch.* 81 (44): 14-15. November 4, 1933.
- Vitamin C Retention in Frozen Strawberries and Strawberry Ice Cream. C. R. Fellers and M. J. Mack. *Ice Cream Trade Jour.* 29, No. 8. August, 1933.
- Insect Pests of Fruit in Massachusetts. A. I. Bourne and W. D. Whitcomb. *Mass. Fruit Growers' Assoc. Rpt.* 1933.
- The Apple Maggot Situation in Massachusetts and How to Meet It. A. I. Bourne. *Proc.* 22d Ann. Meeting, Mass. Tree Wardens' and Foresters' Assoc. 1933.
- To Fill the Gaps in the Basic Data Concerning the Special Expenses of the Potato Crop, Massachusetts Being Taken as an Example. R. L. Mighell. *Soc. Sci. Research Council Bul.* 6, Research in Agricultural Income. June, 1933.
- The Structure, Organization and Functioning of the Farm Labor Market in a Region or Area; Measurement of the Demand for Farm Labor; The Factors Associated with Changes in the Demand for Farm Labor in an Area, and with Changes in Wages of Farm Labor, from Year to Year. R. L. Mighell. *Soc. Sci. Research Council Bul.* 16, Research in Farm Labor. June, 1933.
- Spoilage of Maple Products by Molds. Carl R. Fellers. *Jour. Bact.* 25:67-68. January, 1933.
- The Manufacture of Canned Cranberry Sauce. Carl R. Fellers. *Canning Age* 14:478-480. November, 1933.
- Vitamin Content of Some Massachusetts Grown Apples. Carl R. Fellers. *Mass. Fruit Growers' Assoc. Rpt.* 1933.

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